US009636930B1

(12) United States Patent
Leighton et al.

(10) Patent No.: US 9,636,930 B1
(45) Date of Patent: May 2, 2017

(54) **TRANSPORT WITH MEDIA HOLD DOWN FOR INKJET PRINTERS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/150,841**

(22) Filed: **May 10, 2016**

(51) **Int. Cl.**

B41J 11/00	(2006.01)
B41J 13/10	(2006.01)
B65H 5/08	(2006.01)
B41J 13/16	(2006.01)
B65H 29/04	(2006.01)
B41J 13/22	(2006.01)
B65H 29/02	(2006.01)

(52) **U.S. Cl.**
CPC ***B41J 11/007*** (2013.01); ***B41J 13/10*** (2013.01); ***B41J 13/16*** (2013.01); ***B41J 13/22*** (2013.01); ***B65H 5/085*** (2013.01); ***B65H 29/02*** (2013.01); ***B65H 29/04*** (2013.01)

(58) **Field of Classification Search**
CPC B65H 5/085; B65H 29/02; B65H 29/04; B65H 5/02; B65H 5/14; B65H 2404/34; B65H 29/003; B65H 29/005; B65H 29/045; B65H 29/06; B41J 13/10; B41J 13/22; B41J 11/007; B41J 13/16; B41J 13/24
See application file for complete search history.

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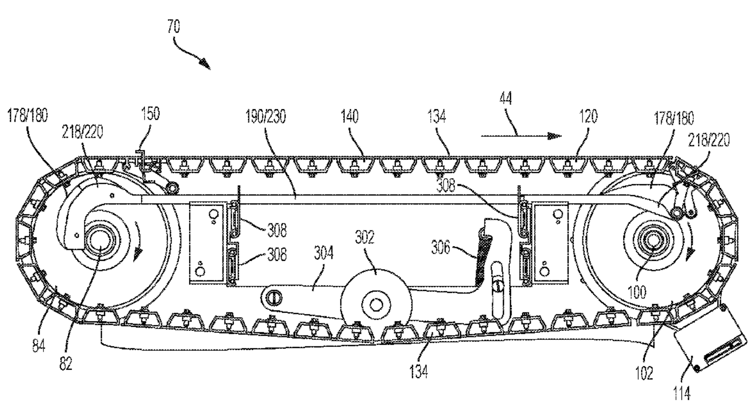
(57) **ABSTRACT**

A transport with media hold down is used with an inkjet printer. A plurality of spar links and vacuum links are connected pivotally together to form an endless belt orbiting around drive wheels and driven wheels. Vacuum links have hollow chambers to hold the media sheet against the endless belt using vacuum. At least one spar is received in a slot on a spar link. The spar extends above the link to receive the media sheet. The spar moves into a clamping position by a cam and follower to clamp the media sheet against the spar link. The media sheet will thus pass beneath the inkjet print head without contact. The spar moves into an extended position by the cam and follower to release the media sheet. The spar moves into a retracted position below the spar link surface by the cam and follower to allow the media sheet to exit the transport.

24 Claims, 28 Drawing Sheets



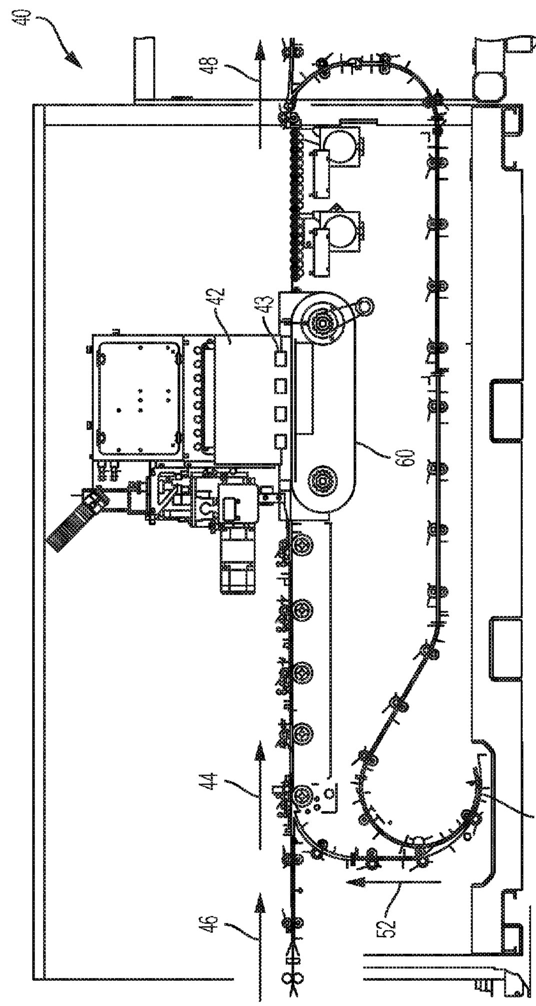


FIG. 1

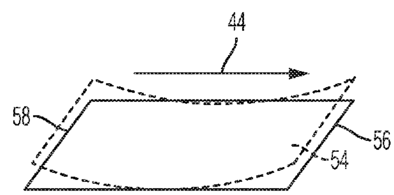


FIG. 2

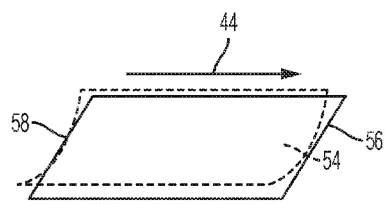


FIG. 3

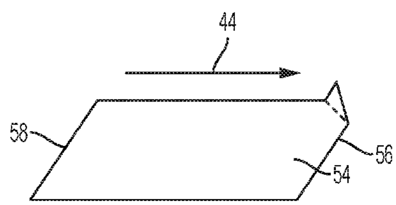


FIG. 4

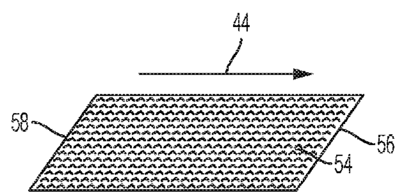


FIG. 5

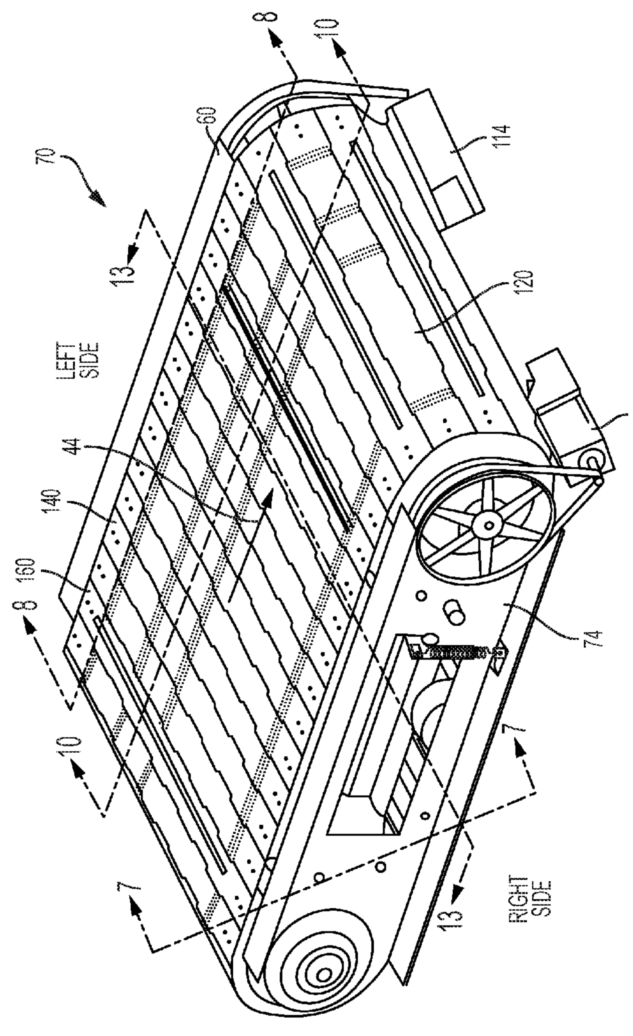

70
60
8
10
114
13
120
LEFT SIDE
44
140
160
8
10
114
74
7
7
13
RIGHT SIDE

FIG. 6

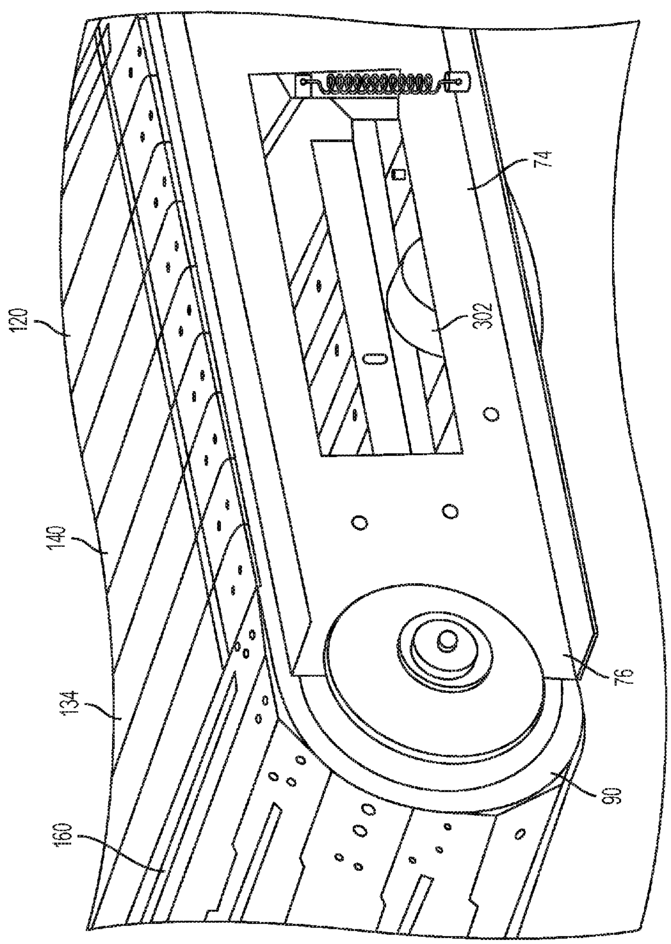


FIG. 7

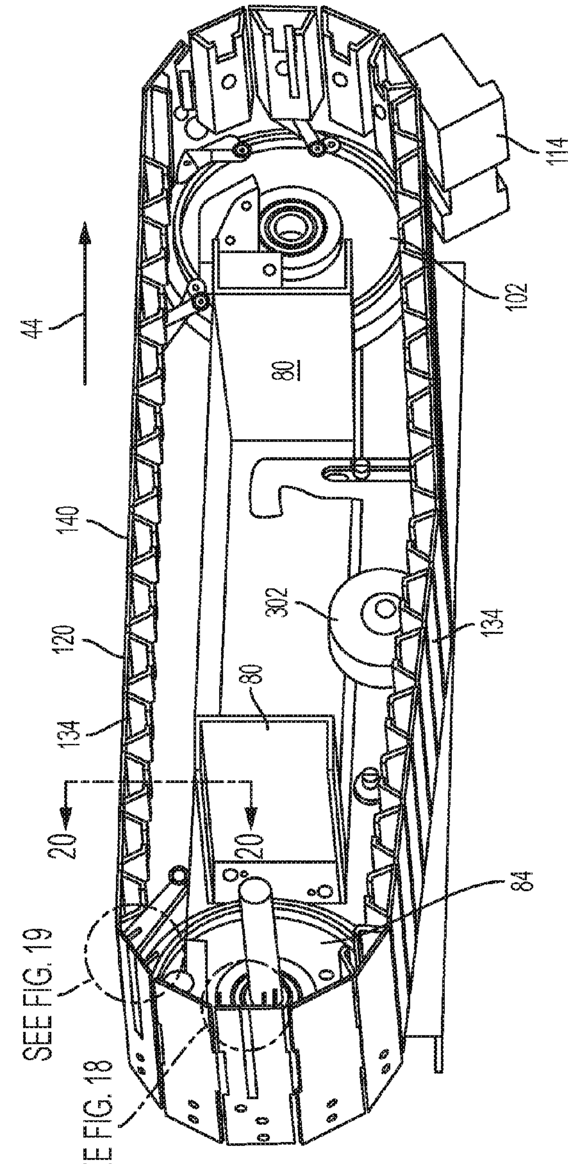


FIG. 8

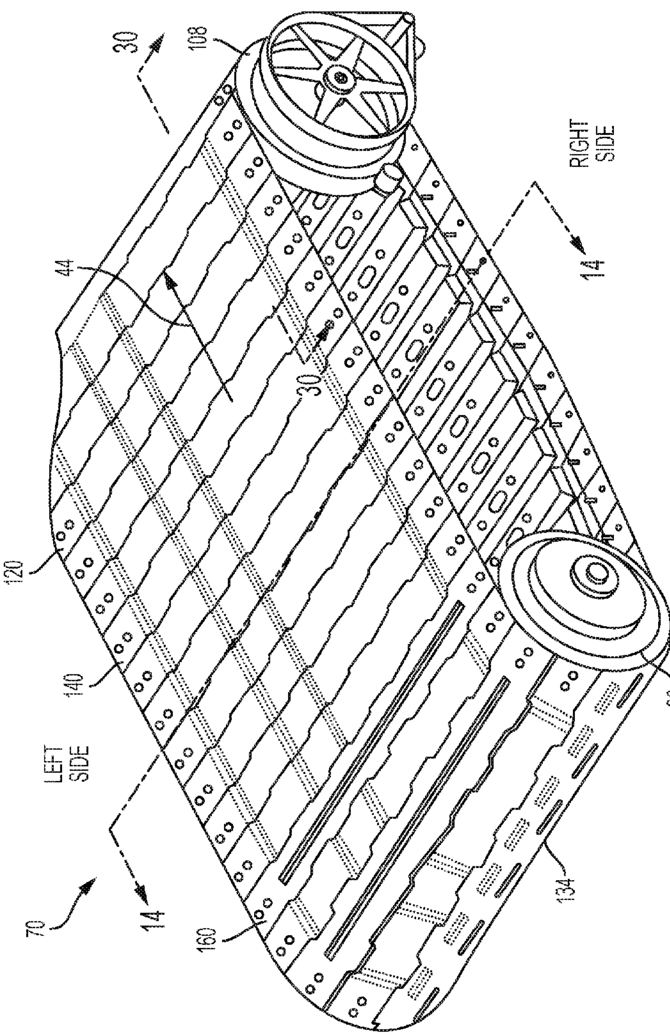
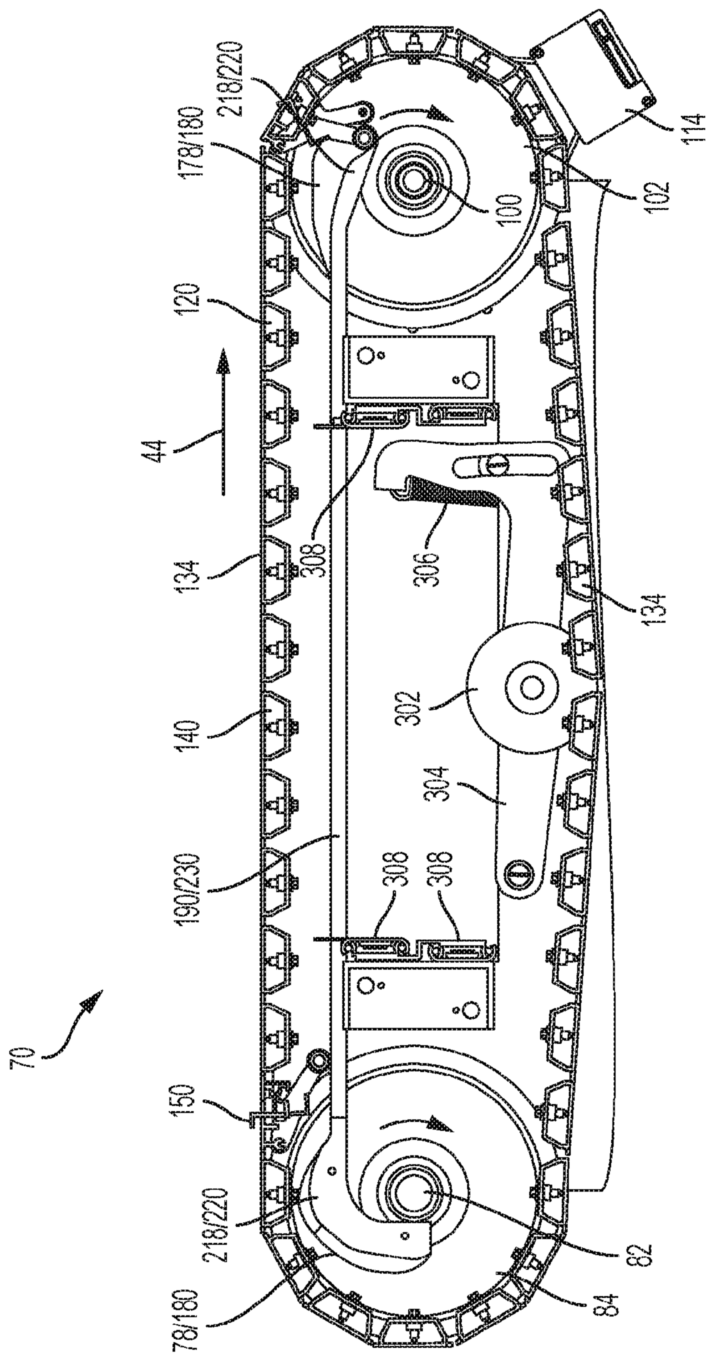


FIG. 9


218/220
178/180
114
100
102
120
44
308
306
134
134
302
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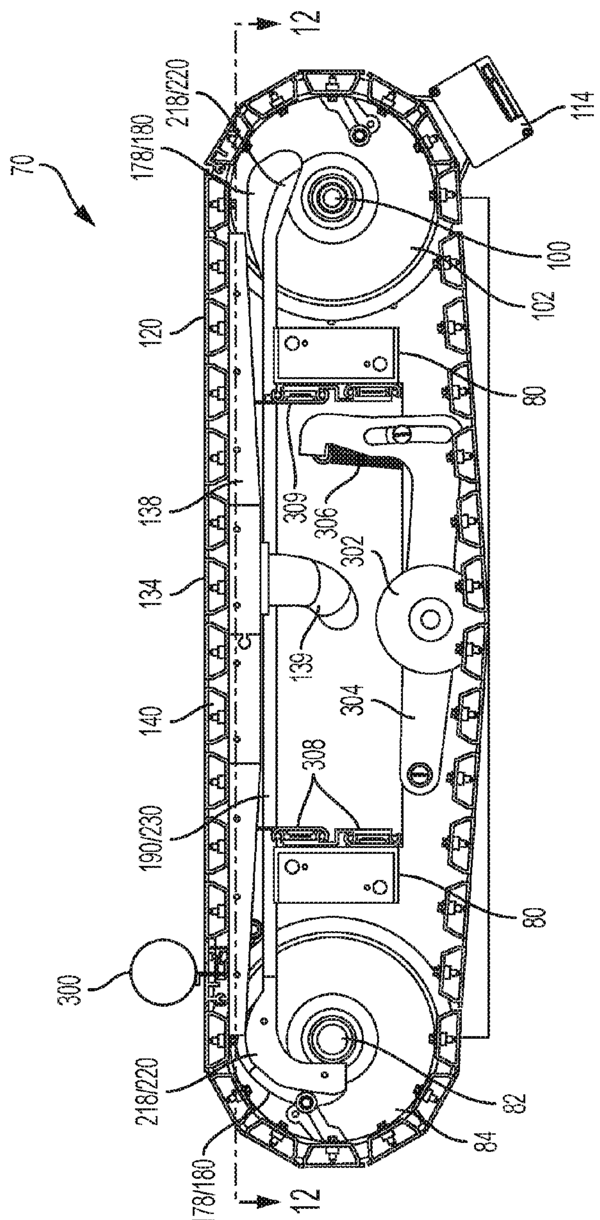
304
190/230
308
308
70
150
218/220
82
84
178/180

FIG. 10


70
12
12
218/220
178/180
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100
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120
80
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308
190/230
80
300
82
218/220
84
178/180

FIG. 11

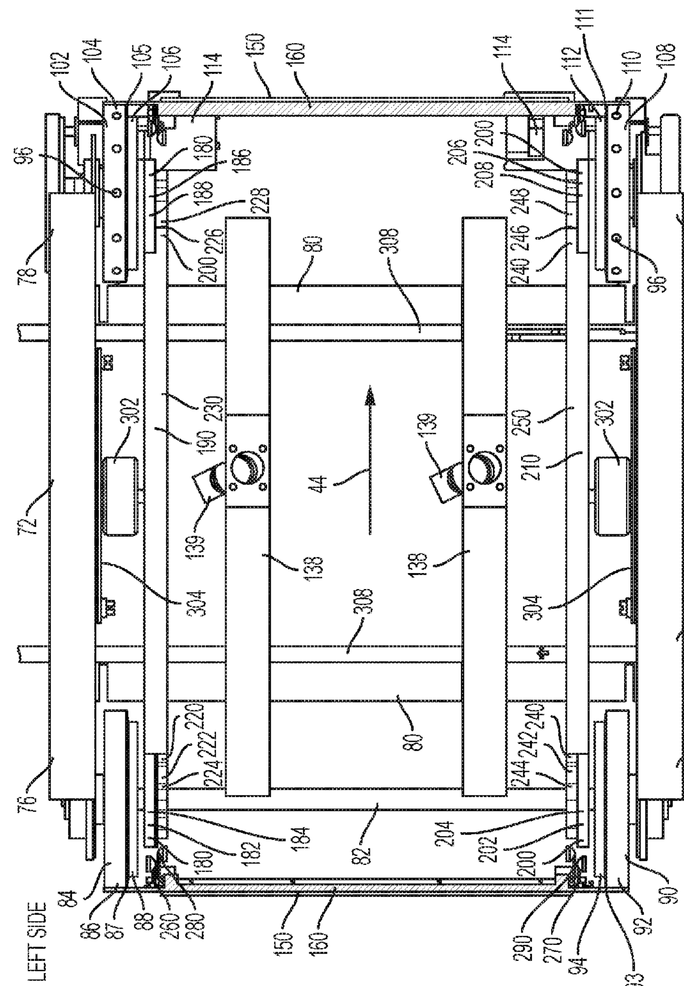


FIG. 12

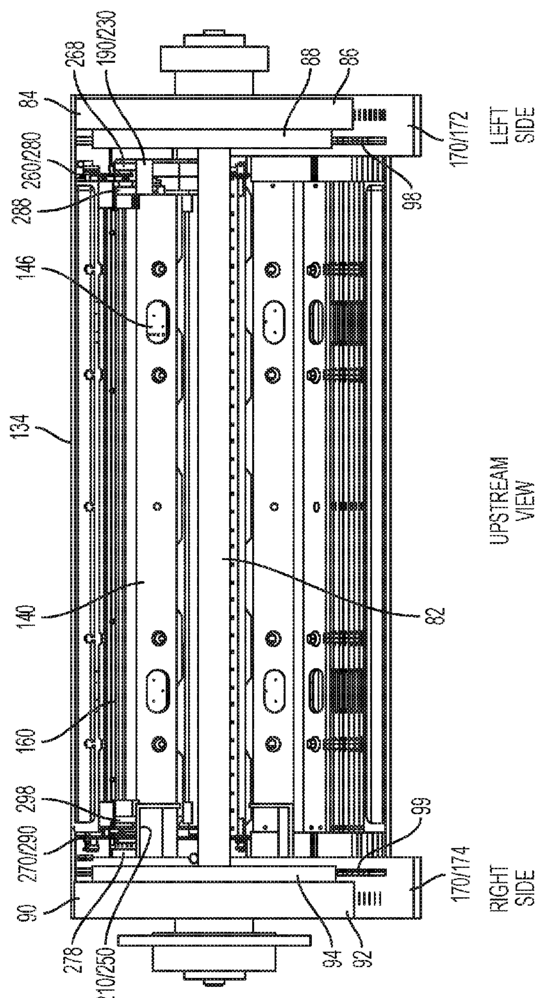
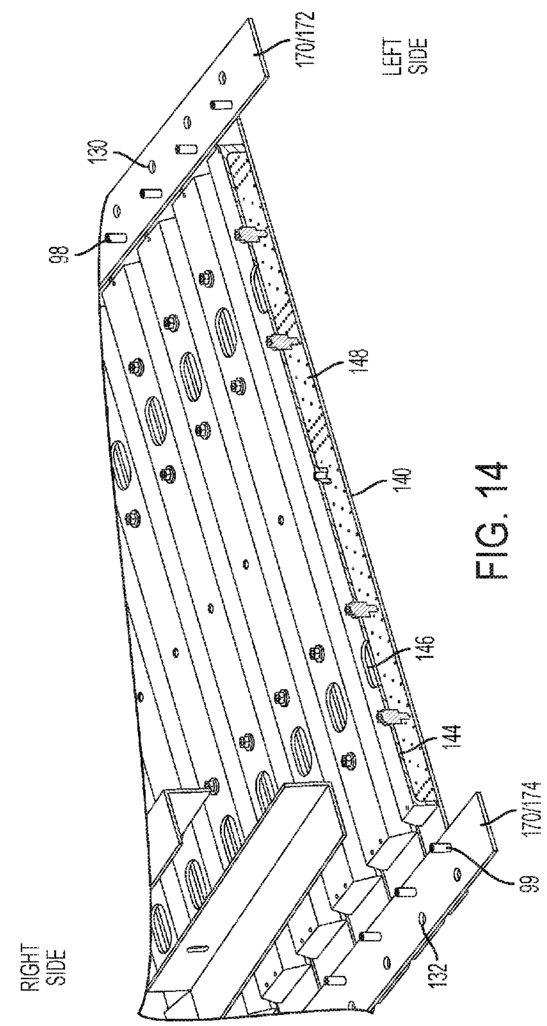

268
190/230
88
86
84
260/280
288
146
134
140
160
298
270/290
90
278
210/250
94
92
82
98
99
170/172
LEFT SIDE
170/174
RIGHT SIDE
UPSTREAM VIEW

FIG. 13


170/172
LEFT SIDE
130
98
148
140
146
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170/174
99
132
RIGHT SIDE

FIG. 14

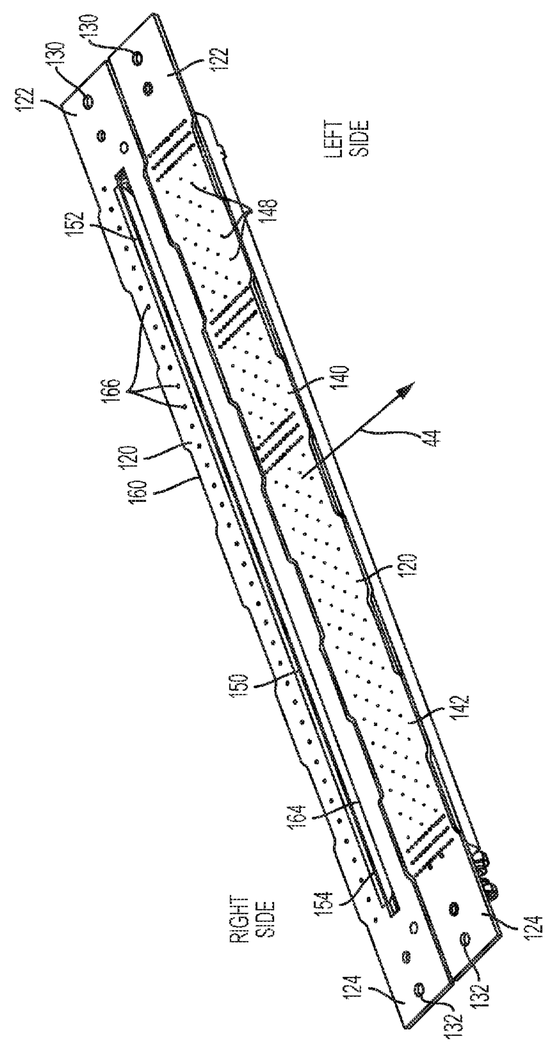
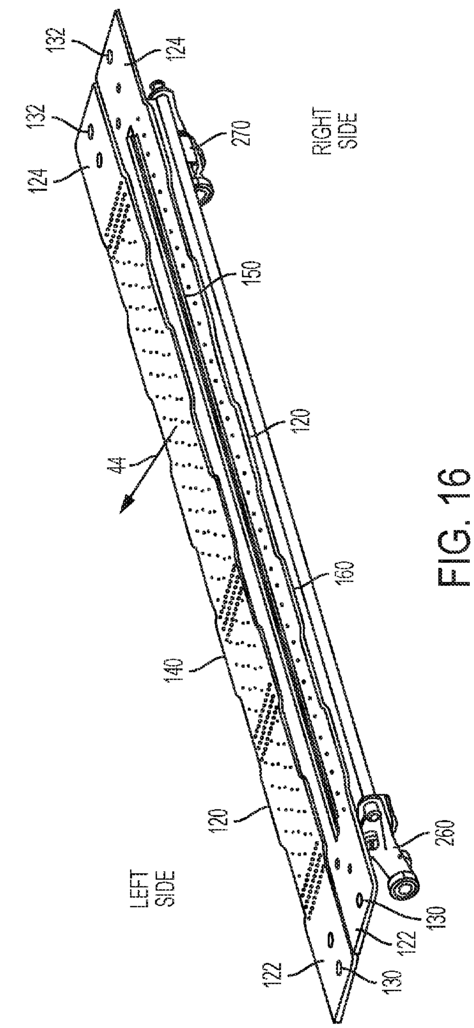
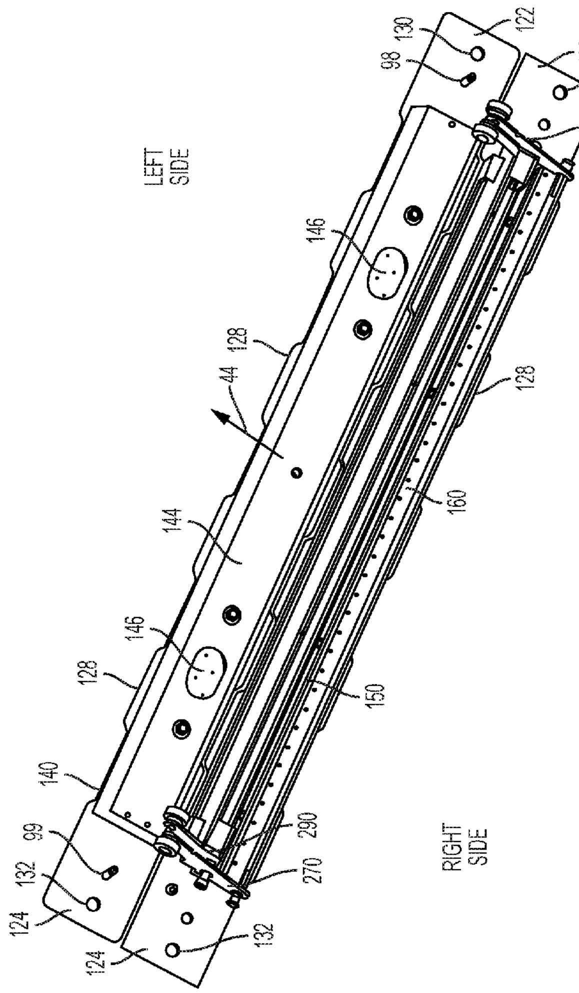

122
130
130
122
LEFT SIDE
148
152
166
140
44
120
160
120
150
142
164
RIGHT SIDE
154
124
132
132
124

FIG. 15



132
124
132
124
270
RIGHT SIDE
150
120
44
160
140
120
260
LEFT SIDE
122
130
122
130

FIG. 16


LEFT SIDE
RIGHT SIDE
122
122
130
130
98
260
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146
128
128
128
44
144
160
150
140
99
132
132
124
124
290
270

FIG. 17

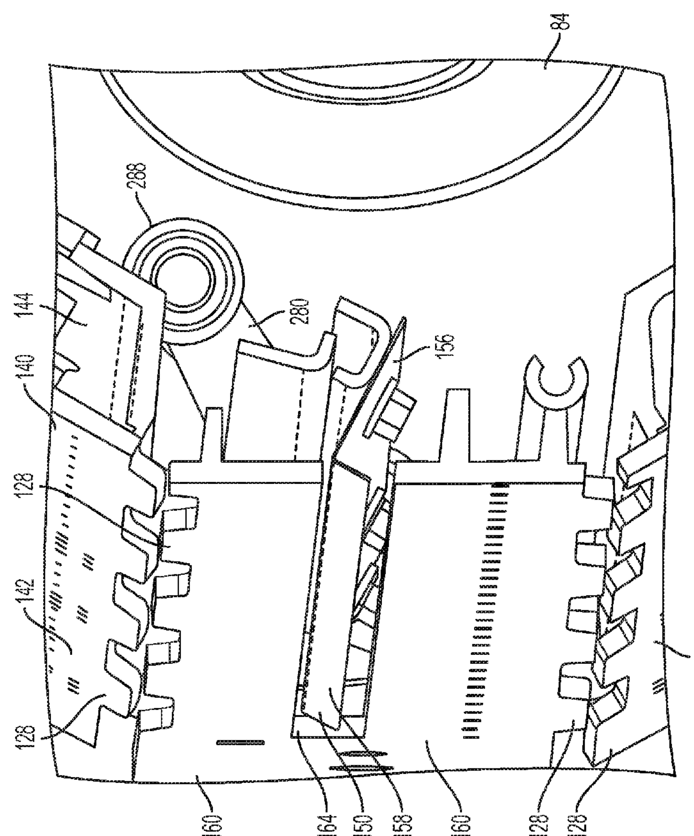

84
288
280
156
144
140
128
142
128
140
160
164
150
158
160
128
128

FIG. 18

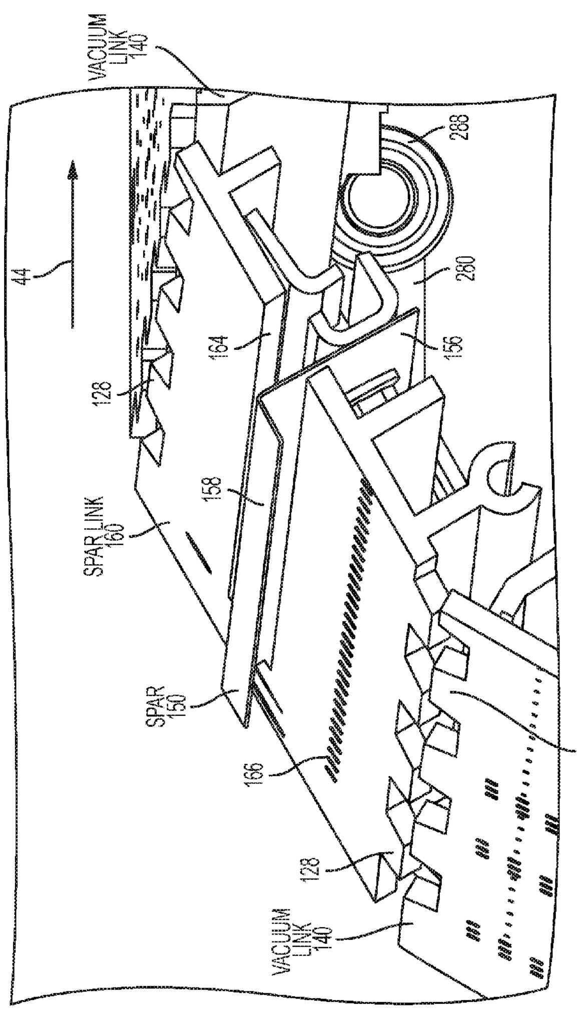

VACUUM LINK 140
288
44
128
164
156
280
SPAR LINK 160
158
SPAR 150
166
128
128
VACUUM LINK 140

FIG. 19

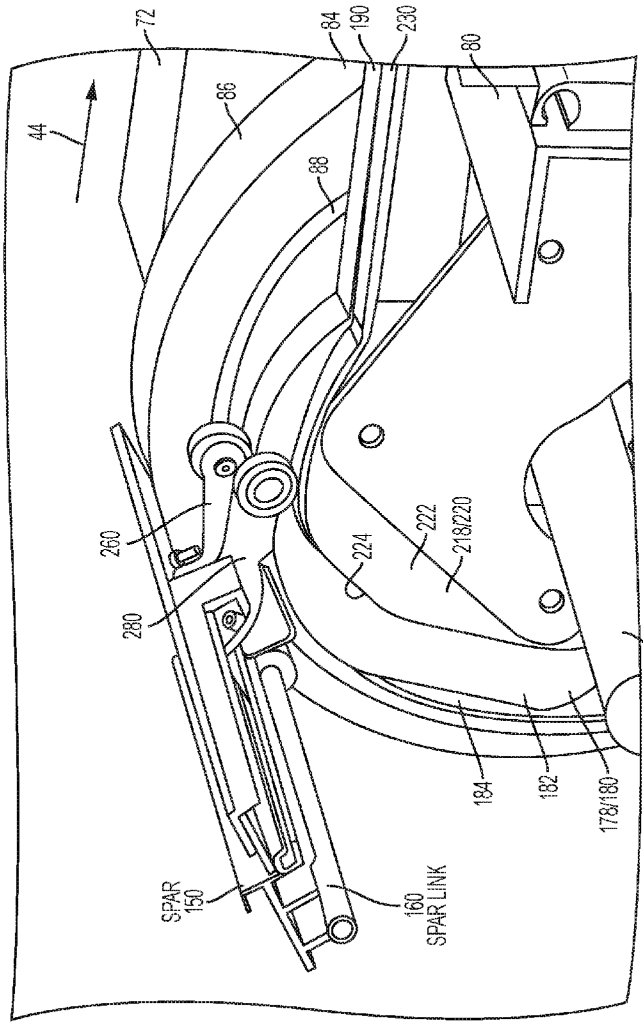
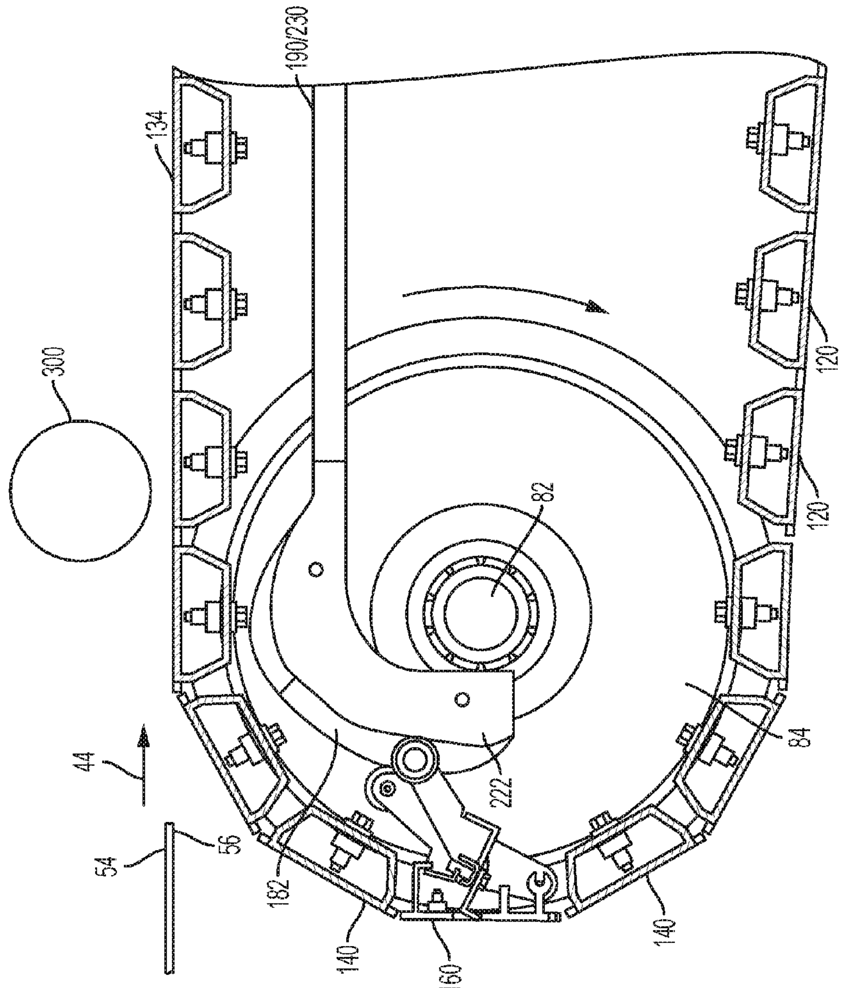

72
84
190
230
80
86
44
88
260
280
222
218/220
224
82
184
182
178/180
SPAR
150
160
SPAR LINK

FIG. 20

FIG. 21



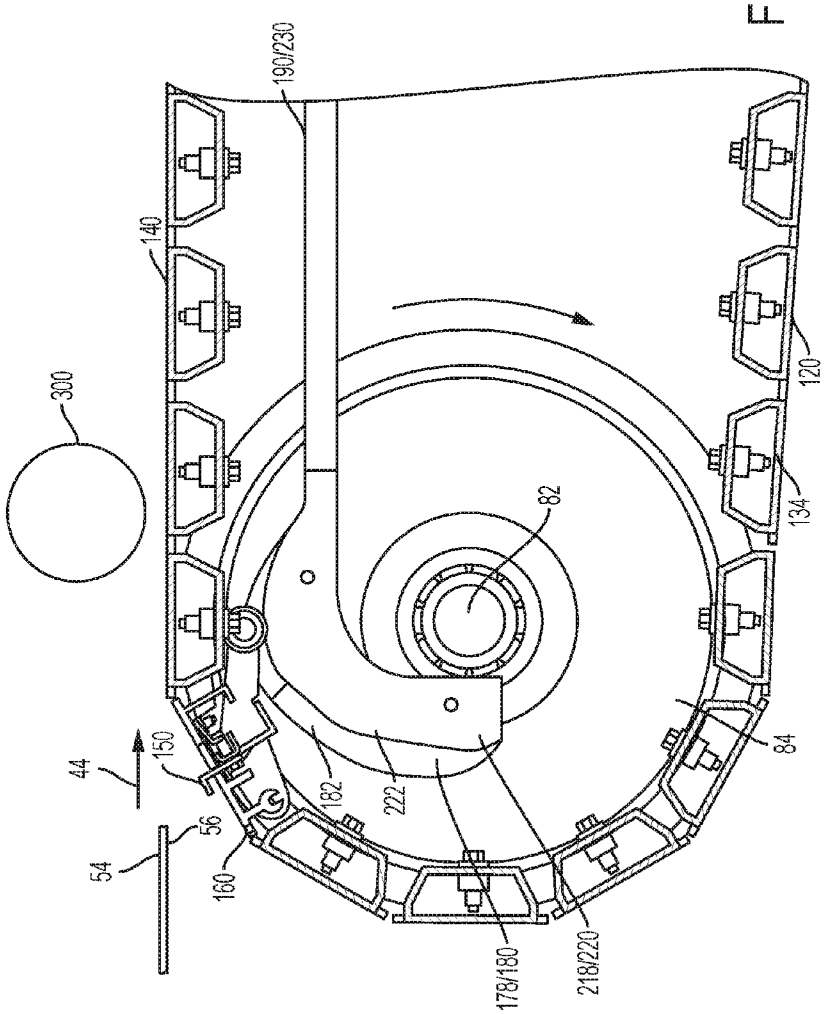

190/230
140
300
120
134
82
84
44
150
182
222
56
54
160
178/180
218/220

FIG. 22

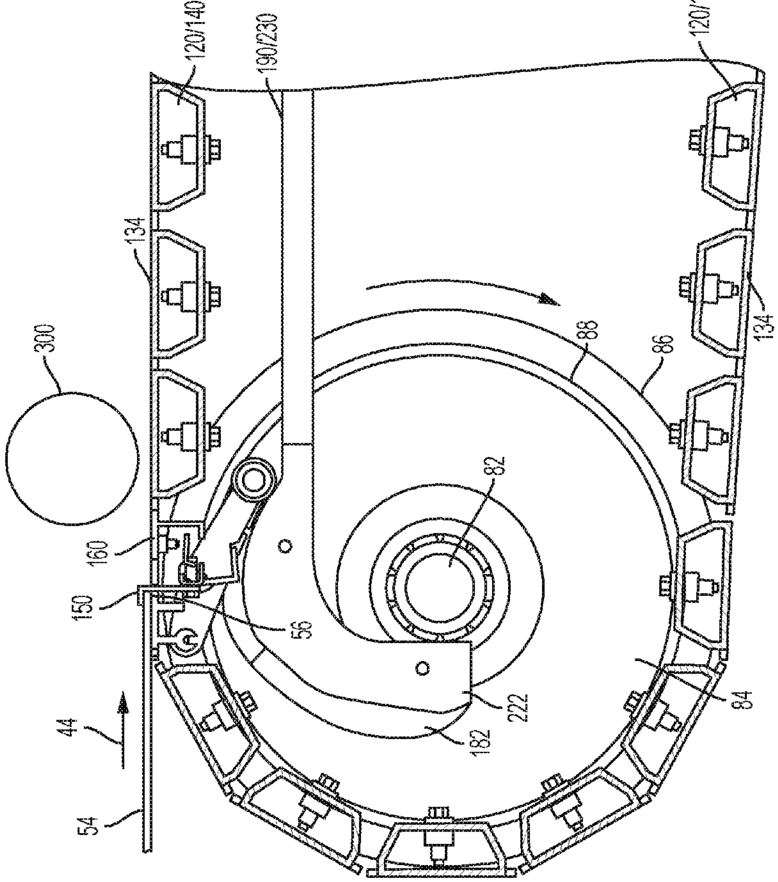

120/140
190/230
134
300
88
86
82
160
150
56
222
84
44
182
54
120/140
134

FIG. 23

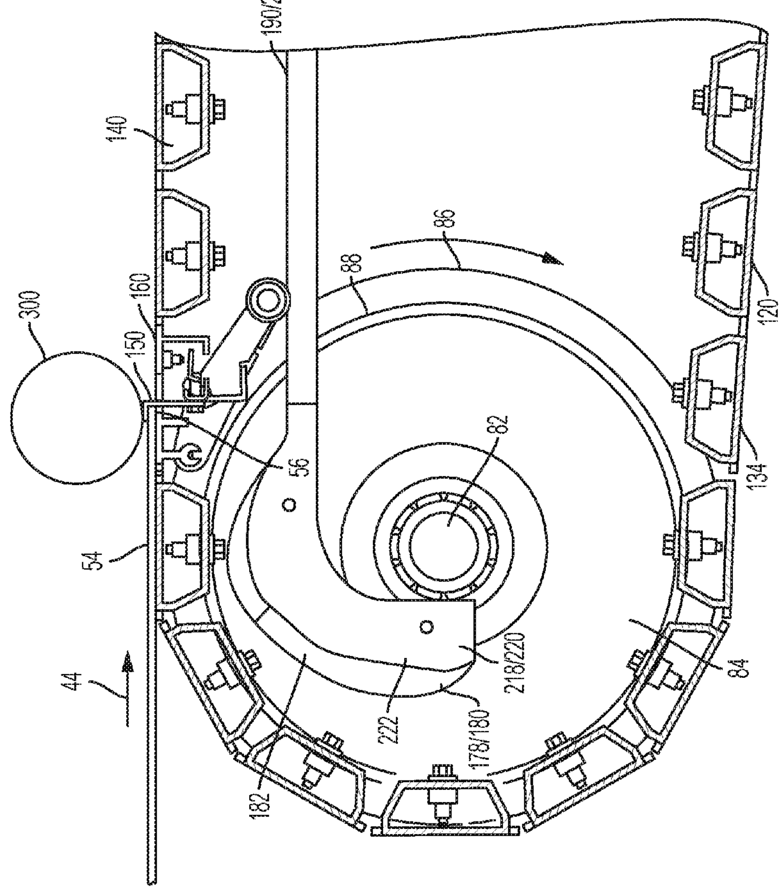

300
160
150
140
190/230
88
86
120
134
82
56
54
44
218/220
84
222
178/180
182

FIG. 24

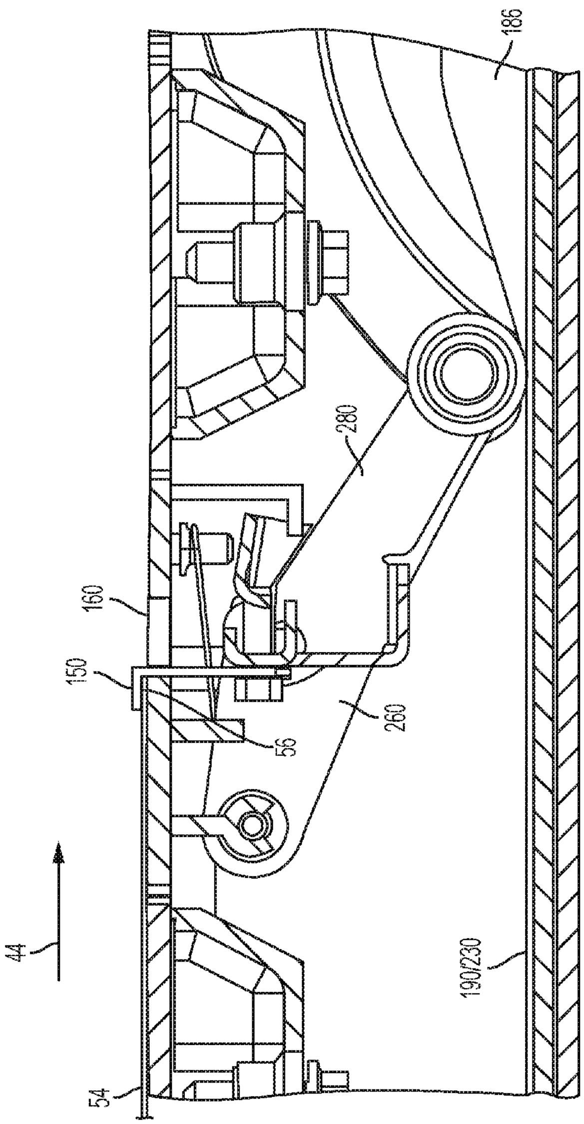


FIG. 25

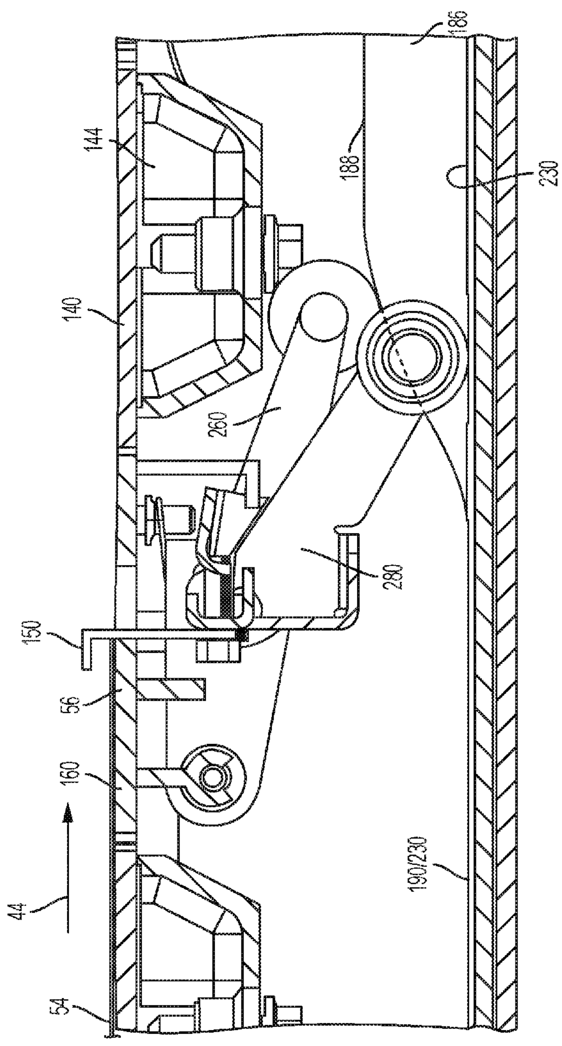


FIG. 26

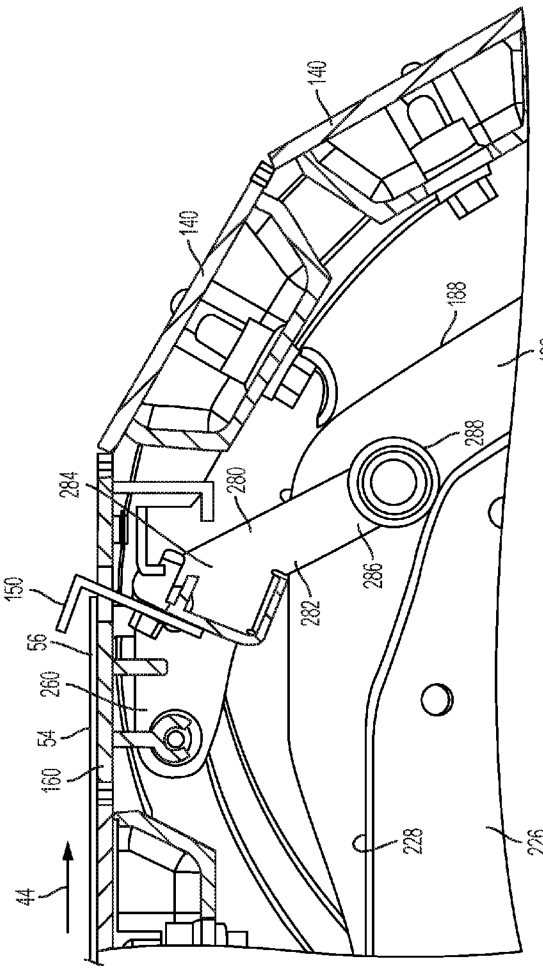


FIG. 27

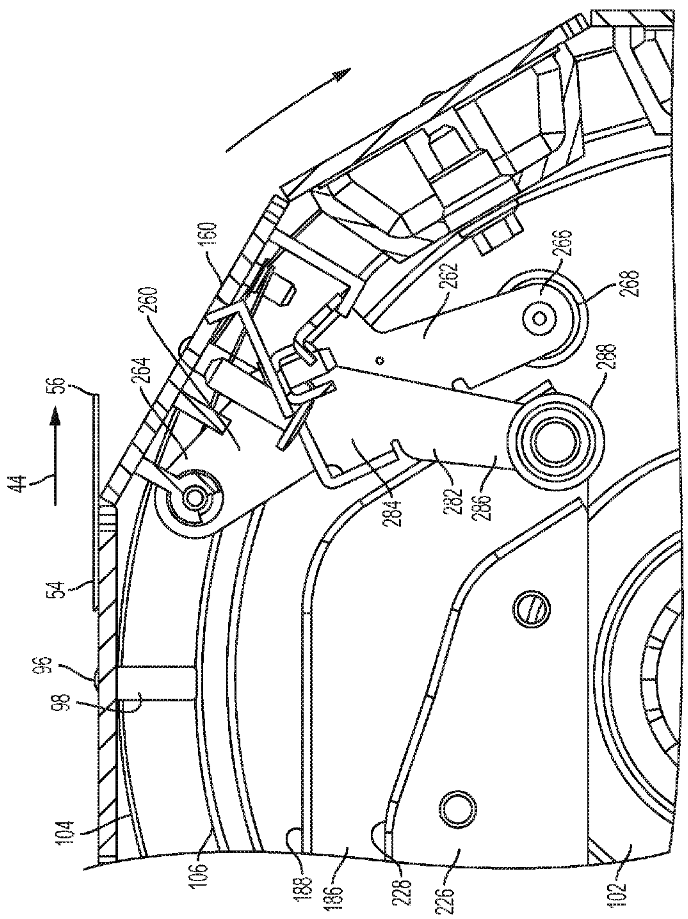

44
56
264
260
160
54
96
98
104
106
188
186
228
226
102
284
282
286
262
266
268
288

FIG. 28

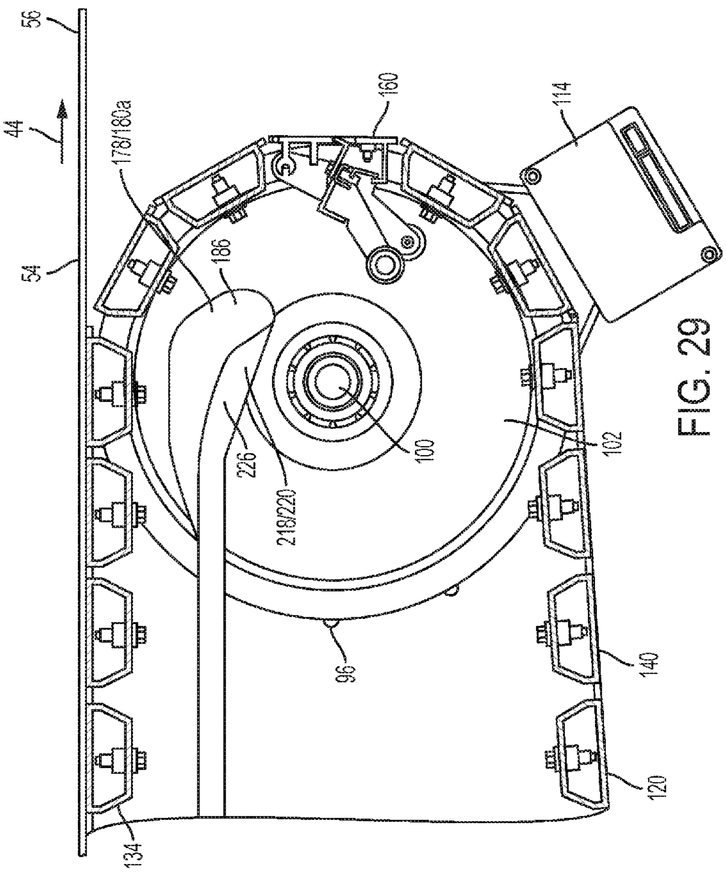


FIG. 29

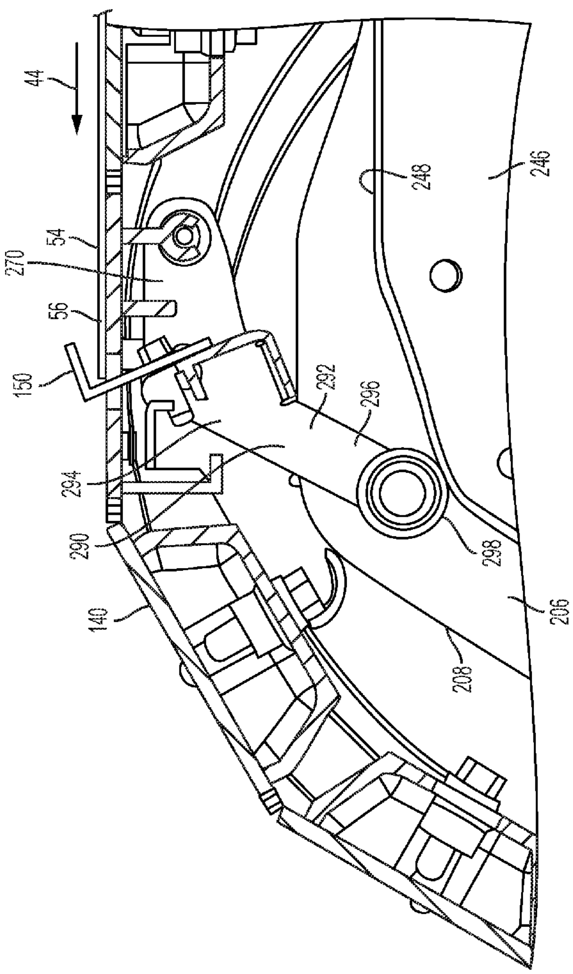


FIG. 30

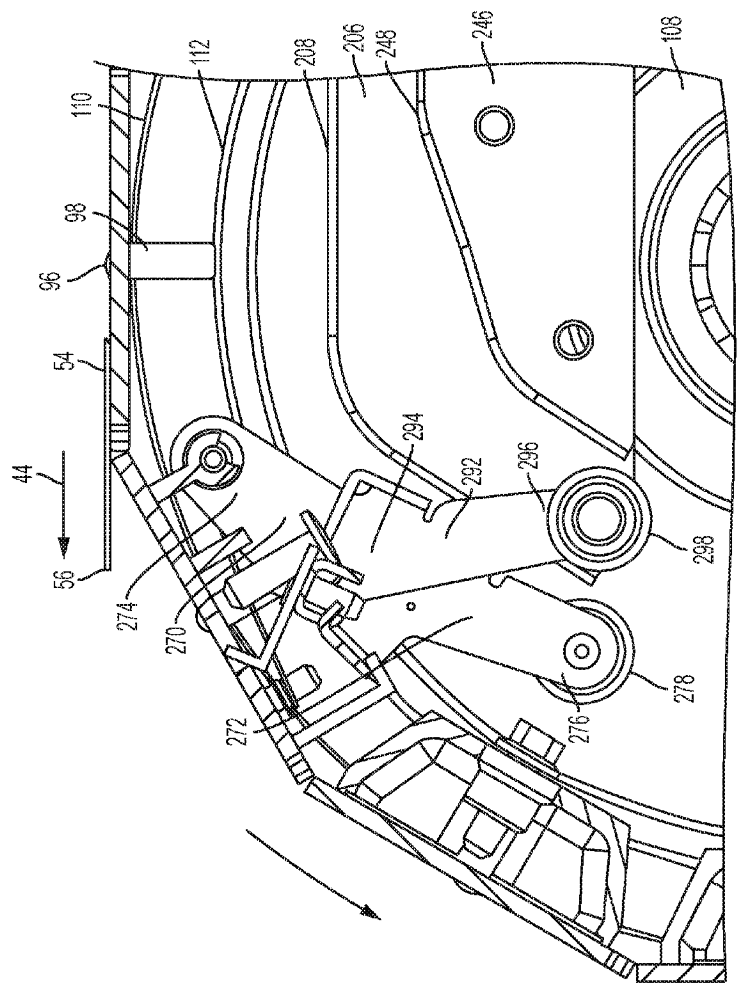

110
112
208
206
248
246
108
98
96
54
44
56
294
292
296
298
274
270
272
276
278

FIG. 31

TRANSPORT WITH MEDIA HOLD DOWN FOR INKJET PRINTERS

INCORPORATION BY REFERENCE

Not applicable.

TECHNICAL FIELD

This invention relates to inkjet digital printing machines, and, more particularly, to an apparatus, system, and method for protecting the printing head from damage due to impaction of media sheets by clamping the lead edge of the media down against the transport.

BACKGROUND

Digital printing machines can take on a variety of configurations. One common process is that of electrostatographic printing, which is carried out by exposing a light image of an original document to a uniformly charged photoreceptive member to discharge selected areas. A charged developing material is deposited to develop a visible image. The developing material is transferred to a medium sheet (paper) and heat fixed.

Another common process is that of direct to paper ink jet printing systems. In ink jet printing, tiny droplets of ink are sprayed onto the paper in a controlled manner to form the image. Other processes are well known to those skilled in the art. The primary output product for a typical digital printing system is a printed copy substrate such as a sheet of paper bearing printed information in a specified format.

The output sheet can be printed on one side only, known as simplex, or on both sides of the sheet, known as duplex printing. In order to duplex print, the sheet is fed through a marking engine to print on the first side, then the sheet is inverted and fed through the marking engine a second time to print on the reverse side. The apparatus that turns the sheet over is called an inverter.

FIG. **1** shows a state-of-the-art inkjet digital printing machine **40**. Printer **40** includes a marking module or engine **42** having an ink jet print head or multiple print heads **43**, disposed centrally on the marking engine **42**, and facing downward. Printer **40** has a media path or process path **44** along which the media sheet **54** moves. Printer **40** has a media path entrance **46** where sheets are fed into the printer by a media sheet feeder (not shown). Printer **40** also has a media path exit **48** where sheets leave the printer and are fed into a finisher (not shown). Printer **40** has an inverter **50** to turn the sheet over for duplex printing. A media sheet **54** leaving the inverter **50** follows arrow **52** back to the marking engine **42** for printing on the reverse side. Arrow **44** indicates the process path direction, which is downstream from entrance **46** toward exit **48**. A vacuum transport conveyor **60** moves the media sheet **54** under the print head **43**.

FIGS. **2**-**5** show that in cut sheet printing devices, under certain conditions, the lead-edge of the paper can curl up and have potential for separating from the marking transport and contact the print head. A sheet **54** with out-of-spec flatness can occur when a duplexed sheet has a heavy ink image on the trail edge **58** of side **1**, which then becomes the lead edge **56** when inverted and curls towards Side **2**. This is most severe when the paper is thin, the aqueous ink coverage is heavy, there is a border bar image near the lead edge, and the cross-process direction image is parallel to the grain direction of the paper (Example: letter size paper, grain-long, long-edge-feed).

In direct-to-paper ink jet marking engines, an ink jet print head **43**, or typically multiple ink jet print heads **43**, are mounted such that the face (where the ink nozzles are located) of each print head is mounted a fixed distance from the surface of the media **54**. The gap is typically 1.5 mm or less. Because the paper curl height can be several millimeters, it poses a risk to the print head because the paper can hit the print head face plate when it passes through the nominally thin gap that the print heads are spaced from the media.

Media sheets **54**, typically paper, can curl or distort in several ways. LE curl is a concave upward bending along the process direction, such that the lead edge **56** (LE) and the trail edge **58** (TE) rise up off the transport **60**, as shown in FIG. **2**. The raised LE can impact multiple print heads across the paper width. Cross curl is a concave upward bending across the process direction, such that the left side and right side edges rise up off the transport, as shown in FIG. **3**. The raised sides can impact multiple print heads. Both LE curl and cross curl are caused by ink on the first side of a duplex print that is inverted.

Dog ear is a crease with upward bending across the process direction at an angle across a corner, as shown in FIG. **4**. The crease can impact multiple print heads downstream. This is caused by sheet damage in the paper path. Print head damage is severe due to greater pressure.

Cockle is multiple bumps or peaks distributed throughout the sheet, as shown in FIG. **5**. The bumps can impact multiple print heads downstream. Cockle is caused by the drying rate of ink, especially aqueous based inks.

For ideal image quality, the print head gap or distance of the print head **43** to the sheet **54** should be maintained at less than 1.2 mm, preferably within 1 mm. The media sheet traveling at one meter per second must pass freely under the print heads. The sheet must not contact the face of the print head, or serious damage will result. This requirement poses a challenge for cut sheet media since the corners, edges and body of the sheet may not be completely flat. The use of a hold down transport such as a vacuum conveyor helps to maintain the sheet flat and within the gap for the most part. Purposely delivering sheets with downward curl from the sheet supply tray also helps to hold the sheet flat. Nevertheless it is not guaranteed that a sheet is flat over the entire surface.

Ink jet print heads are very delicate and can easily be damaged if the face of the print head is contacted by the media which is passing nearby. The print heads are also very expensive. Thus, it is very important to minimize any risk of damaging these print heads.

Accordingly, there is a need to provide a print head protection device for inkjet printers that will prevent print head damage, and also prevent jamming of sheets on the vacuum transport conveyor.

There is a further need to provide a print head protection device for inkjet printers of the type described and that will match the high production rate of a digital printing machine.

There is a yet further need to provide a print head protection device for inkjet printers of the type described and that is mechanically simple and robust, thereby minimizing cost.

SUMMARY

In one aspect, a transport with media hold down is used in connection with an inkjet printer having an inkjet print head. A media sheet has a lead edge and a trail edge, and moves in a process direction along a process path. The

transport with media hold down comprises a pair of driven wheels and a pair of drive wheels spaced apart from the driven wheels. A plurality of links connected pivotally together form an endless belt adapted for orbiting around the drive wheels and the driven wheels.

At least one of the plurality of links is a spar link having a spar link surface facing away from the endless belt. The spar link has a spar link slot. The remaining links are vacuum links. Each vacuum link has a hollow chamber communicating with a vacuum source. The vacuum holds the media sheet against the endless belt.

A cam is disposed adjacent the endless belt. A follower is adapted to operatively follow the cam.

At least one spar is movably mounted on the spar link and is received in the spar link slot. The spar is operatively connected to the follower. The spar has a clamp flange. The spar is adapted to move into an extended position above the spar link surface by the cam and follower. In this position, it will receive the media sheet.

The spar is adapted to move into a clamping position by the cam and follower with the media sheet lead edge sandwiched between the clamp flange and the spar link surface. In this position, it will hold the media sheet lead edge clamped against the spar link surface. The media sheet will thus pass beneath the inkjet print head without contacting the inkjet print head.

The spar is adapted to move into the extended position by the cam and follower. In this position, it will release the media sheet.

The spar is adapted to move into a retracted position below the spar link surface by the cam and follower. In this position, it will allow the media sheet to exit the transport.

In another aspect, a transport with media hold down is used in connection with an inkjet printer having an inkjet print head. A media sheet has a lead edge and a trail edge, and moves in a process direction along a process path. The transport with media hold down comprises a frame extending longitudinally in the process direction from a first end to an opposite second end. At least one first axle is mounted on the frame at the first end. A pair of driven wheels is mounted for rotation on the at least one first axle. At least one second axle is mounted on the frame at the second end. A pair of drive wheels is mounted for rotation on the at least one second axle. At least one drive motor operatively drives at least one of the drive wheels.

A plurality of links is operatively connected together. Each link extends between opposite ends transversely to the process direction. Each link has two opposed generally parallel link edges. Each link edge is juxtaposed with an adjacent link edge on each adjacent link. The plurality of links is operatively drivingly attached to the drive wheels. Each link is adapted for pivotal motion with respect to each adjacent link. Each link has a link surface facing outward. The plurality of links is adapted for holding the media sheet generally flat against each link surface and conveying the media sheet in the process direction. At least one of the plurality of links is a spar link. The remaining links are vacuum links.

At least one spar extends between opposite ends juxtaposed with the spar link opposite ends. The spar link has a spar link surface facing outward. The spar link has a slot extending through the spar link surface to receive the spar. The spar is adapted to move into a retracted position below the spar link surface. The spar is also adapted to move into an extended position above the spar link surface.

The spar has a clamp flange. The spar is adapted to move into a clamping position with the media sheet lead edge sandwiched between the clamp flange and the spar link surface. In this position, the spar will hold the media sheet lead edge clamped against the spar link surface. The media sheet will thus pass beneath the inkjet print head without contacting the inkjet print head.

At least one lift cam has an entry portion with an entry profile disposed adjacent the first end. The lift cam has an exit portion with an exit profile disposed adjacent the second end.

At least one lift follower is attached to the at least one spar link. The spar is operatively connected to the lift follower. The lift follower is adapted to follow the lift cam entry profile. The lift follower will move the spar from the retracted position to the extended position to receive the media sheet. The lift follower will then move the spar to the clamping position to clamp the media sheet.

The lift follower is adapted to follow the lift cam exit profile. The lift follower will move the spar from the clamping position to the extended position to release the media sheet from the clamping position. The lift follower will then move the spar to the retracted position. In this position, the media sheet is allowed to exit the transport.

In yet another aspect, a transport with media hold down is used in connection with an inkjet printer having an inkjet print head. A media sheet has a lead edge and a trail edge, and moves in a process direction along a process path. The transport with media hold down comprises a pair of side frames generally parallel and spaced apart. The side frames extend longitudinally in the process direction between opposite first and second ends. The second ends are downstream in the process direction from the first ends. At least one cross frame extends transversely between the side frames. At least one first axle is mounted on the side frames at the first ends. A pair of driven wheels is mounted for rotation on the at least one first axle. At least one second axle is mounted on the side frames at the second ends. A pair of drive wheels is mounted for rotation on the at least one second axle. At least one drive motor operatively drives at least one of the drive wheels.

A plurality of links is provided. Each link extends between opposite ends transversely to the process direction. The opposite ends of each link are disposed adjacent the side frames. Each link has two opposed generally parallel link edges extending transversely to the side frames. Each link edge has serrations interlaced with corresponding serrations along the link edge on each adjacent link. In this manner, the link edges will support the media sheet transversely across the transport.

At least one flexible drive belt is attached to each link of the plurality of links to pivotally connect each link together. The flexible drive belt is adapted to operatively move the plurality of links in an orbital motion around the drive wheels and the driven wheels.

An endless belt is formed by the plurality of links operatively connected together. The endless belt extends partway around the drive wheels and partway around the driven wheels. The endless belt also extends between the drive wheels and the driven wheels. The endless belt is operatively drivingly attached to the drive wheels.

Each link has a link surface facing outward away from the endless belt. The plurality of links is adapted for holding the media sheet generally flat against each link surface and conveying the media sheet in the process direction. At least one of the plurality of links is a spar link. The remaining links are vacuum links.

At least one spar extends between opposite ends. The opposite ends of the spar are juxtaposed with the spar link respective opposite ends. The spar is coextensive with the one of the plurality of links defining the spar link. The spar link has a spar link surface facing outward away from the endless belt. The spar link has a slot extending through the spar link surface to receive the spar. The spar is adapted to move into a retracted position below the spar link surface to allow for paper exit. The spar is also adapted to move into an extended position above the spar link surface to create a stop and clamp for the paper lead edge.

The spar is L-shaped in cross-section uniformly between the spar ends. The spar has a mount flange and a clamp flange, which together form the L-shape. The spar is adapted to move into a clamping position with the media sheet lead edge sandwiched between the clamp flange and the spar link surface. In this position, the spar will hold the media sheet lead edge clamped against the spar link surface. The media sheet will thus pass beneath the inkjet print head without contacting the inkjet print head.

At least one lift cam is provided, typically one on each end of the spar. The lift cam has an entry portion with an entry profile. The lift cam also has an exit portion with an exit profile. A lift track extends between the entry portion and the exit portion. The lift cam lies generally in a plane that is generally parallel to the side frames. The entry portion is juxtaposed with one of the driven wheels. The exit portion is juxtaposed with a corresponding one of the drive wheels.

At least one lift follower is attached to the at least one spar link. The spar is operatively connected to the lift follower. The lift follower is adapted to follow the lift cam entry profile to move the spar from the retracted position to the extended position, where it will receive the media sheet. The lift follower will then move the spar to the clamping position to clamp the media sheet.

The lift follower is adapted to follow the lift track so as to retain the spar in the clamping position during printing. The lift follower is adapted to then follow the lift cam exit profile so as to move the spar from the clamping position to the extended position to release the media sheet from the clamping position. The lift follower will then move the spar to the retracted position, thus allowing the media sheet to exit the transport.

In still another aspect, a method is disclosed for holding a media sheet down on a transport. The method is used in connection with an inkjet printer having an inkjet print head. A media sheet has a lead edge and a trail edge, and moves in a process direction along a process path. The method comprises connecting a plurality of links pivotally together and orbiting the links edgewise around drive wheels and driven wheels. This will form an endless belt defining the transport. The media sheet is transported in the process direction with the endless belt.

A spar is movably mounted on at least one link of the plurality of links. The spar is moved into a clamping position with a cam and follower. The media sheet lead edge is clamped to the at least one link by means of the spar. The media sheet is held generally flat against the endless belt surface with the spar during printing. The spar moves into an extended position with the cam and follower so as to release the media sheet. The spar moves into a retracted position with the cam and follower so as to allow the media sheet to exit the transport.

These and other aspects, objectives, features, and advantages of the disclosed technologies will become apparent from the following detailed description of illustrative embodiments thereof, which is to be read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic side elevational, sectional view of an exemplary prior art production printer suitable for use with the invention.

FIG. **2** is a schematic isometric view of a media sheet showing LE curl.

FIG. **3** is a schematic isometric view of a media sheet showing cross curl.

FIG. **4** is a schematic isometric view of a media sheet showing dog ear.

FIG. **5** is a schematic isometric view of a media sheet showing cockle.

FIG. **6** is a side perspective view of a transport with media hold down constructed in accordance with the invention.

FIG. **7** is an enlarged, detail perspective view of the transport with media hold down of FIG. **6**, taken along lines **7-7** of FIG. **6**.

FIG. **8** is a side perspective cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **8-8** of FIG. **6**.

FIG. **9** is another side perspective view of the transport with media hold down of FIG. **6**, with the side frame, cross frame, and tensioner removed.

FIG. **10** is a side elevational cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the hold down mechanism.

FIG. **11** is a side elevational cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the vacuum plenum.

FIG. **12** is a top, plan, cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **12-12** of FIG. **11**, and showing the transport with the endless belt removed and showing the vacuum rails.

FIG. **13** is a side elevational cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **13-13** of FIG. **6**, and showing the upstream driven axle and wheels, and with the side frame, cross frame, and tensioner removed.

FIG. **14** is a side elevational cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **14-14** of FIG. **9**, and showing the vacuum links.

FIG. **15** is a top perspective view of a vacuum link and a spar link.

FIG. **16** is another top perspective view of the vacuum link and the spar link, showing the followers.

FIG. **17** is a bottom perspective view of the vacuum link and the spar link, showing the spar and followers.

FIG. **18** is a side perspective detail view of the spar link adjacent the driven wheel, taken at detail **18** of FIG. **8**, and showing the spar link in the retracted position.

FIG. **19** is another side perspective detail view of the spar link adjacent the driven wheel, taken at detail **19** of FIG. **8**, and showing the spar link in the extended position.

FIG. **20** is yet another side perspective detail view of the spar link adjacent the left driven wheel, taken at view **20-20** of FIG. **8**, and showing the spar link in the extended position, and the followers on the left entry cam.

FIG. **21** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left driven wheel, the left entry cams, and the spar in the retracted position.

FIG. **22** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left driven wheel, the left entry cams, and the spar in the extended position.

FIG. **23** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left driven wheel, the left entry cams, and the spar in the clamping position.

FIG. **24** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left driven wheel, the left entry cams, and the spar in the clamping position advancing in the process direction.

FIG. **25** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left drive wheel, the left exit cams, and the spar in the clamping position.

FIG. **26** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left exit cams, and the spar in the extended position.

FIG. **27** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left drive wheel, the left exit cams, and the spar in the extended tilted position.

FIG. **28** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left drive wheel, the left exit cams, and the spar in the retracted position to allow the paper to exit.

FIG. **29** is a side elevational detail cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **10-10** of FIG. **6**, and showing the left drive wheel, the left exit cams, and the spar in the retracted position orbiting past the exit cams.

FIG. **30** is a side elevational detail, partial cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **30-30** of FIG. **9**, and showing the right drive wheel, the right exit cams, and the spar in the extended tilted position advancing in the process direction.

FIG. **31** is a side elevational detail, partial cross-sectional view of the transport with media hold down of FIG. **6**, taken along lines **30-30** of FIG. **9**, and showing the right drive wheel, the right exit cams, and the spar in the retracted position orbiting past the exit cams.

DETAILED DESCRIPTION

Describing now in further detail these exemplary embodiments with reference to the Figures as described above, the system is typically used in a select location or locations of the paper path or paths of various conventional media handling assemblies. Thus, only a portion of an exemplary media handling assembly path is illustrated herein. It should be noted that the drawings herein are not to scale.

As used herein, a "printer," "printing assembly" or "printing system" refers to one or more devices used to generate "printouts" or a print outputting function, which refers to the reproduction of information on "substrate media" or "media substrate" or "media sheet" for any purpose. A "printer," "printing assembly" or "printing system" as used herein encompasses any apparatus, such as a digital copier, bookmaking machine, facsimile machine, multi-function machine, etc. which performs a print outputting function.

A printer, printing assembly or printing system can use an "electrostatographic process" to generate printouts, which refers to forming and using electrostatic charged patterns to record and reproduce information, a "xerographic process", which refers to the use of a resinous powder on an electrically charged plate to record and reproduce information, or other suitable processes for generating printouts, such as an ink jet process, a liquid ink process, a solid ink process, and the like. Also, such a printing system can print and/or handle either monochrome or color image data.

As used herein, "media substrate" or "media sheet" refers to, for example, paper, transparencies, parchment, film, fabric, plastic, photo-finishing papers or other coated or non-coated substrates on which information can be reproduced, preferably in the form of a sheet or web. While specific reference herein is made to a sheet or paper, it should be understood that any media substrate in the form of a sheet amounts to a reasonable equivalent thereto. Also, the "leading edge" or "lead edge" LE of a media substrate refers to an edge of the sheet that is furthest downstream in the process direction. The "trailing edge" or "trail edge" TE is the upstream edge. LEF means long edge feed, wherein the side (longer of the two edges) of the letter moves in the process direction. SEF means short edge feed, wherein the end (shorter of the two edges) of the letter moves downstream. Sheet to sheet pitch is the distance between consecutive media sheets.

As used herein, a "media handling assembly" refers to one or more devices used for handling and/or transporting media substrate, including feeding, printing, finishing, registration and transport systems. A media transport is a hold-down and conveying apparatus for moving the media along the process path. The media transport in the print zone or image transfer zone is instrumental in holding the media flat as it passes under the print heads. The media transport often utilizes a belt operating over a platen. To aid in holding the media flat either a vacuum or an electrostatic field is employed, sometimes both in combination.

As used herein, the terms "process" and "process direction" refer to a procedure of moving, transporting and/or handling a substrate media sheet. The process direction is a flow path the sheet moves in during the process. The left and right sides of the transport are defined looking downstream in the process direction.

Referring now to the drawings, a transport with media hold down **70** is used in connection with an inkjet printer **40** having an inkjet print head **43**. A media sheet **54** has a lead edge **56** and a trail edge **58**, and moves in a process direction **44** along a process path **44**. The transport with media hold down **70** comprises a pair of side frames, including a left side frame **72** and a right side frame **74** generally parallel and spaced apart. The side frames **72**, **74** extend longitudinally in the process direction **44** between opposite first **76** and second **78** ends. The second ends **78** are downstream in the process direction from the first ends **76**. At least one cross frame **80** extends transversely between the side frames **72**, **74**. Typically, two cross frames **80** will be used.

At least one first axle **82** is mounted on the side frames **72**, **74** at the first ends **76**. A pair of driven wheels includes a left driven wheel **84** and a right driven wheel **90**. The left and right driven wheels **84**, **90** are mounted for rotation on the first axle **82**. The left **84** and right **90** driven wheels each has an outer rim with a circumference. The left driven wheel **84** has an outer rim **86**. The right driven wheel **90** has an outer rim **92**. The left **84** and right **90** driven wheels each has an inner rim with a circumference. The left driven wheel **84** has an inner rim **88**. The right driven wheel **90** has an inner rim **94**. In each case, the inner rim is smaller in diameter than the outer rim. In each case, a shoulder extends between the outer rim and the inner rim. The left driven wheel **84** has a shoulder **87**. The right driven wheel **90** has a shoulder **93**.

At least one second axle **100** is mounted on the side frames **72**, **74** at the second ends **78**. Typically, two second axles **100** are employed, one on each of the side frames **72**,

74. A pair of drive wheels includes a left drive wheel **102** and a right drive wheel **108**. Each drive wheel **102**, **108**, is drivingly attached to one of the second axles **100**. The left **102** and right **108** drive wheels are mounted for rotation on the second axles **100**. The left **102** and right **108** drive wheels each has an outer rim with a circumference. The left drive wheel **102** has an outer rim **104**. The right drive wheel **108** has an outer rim **110**. The left **102** and right **108** drive wheels each has an inner rim with a circumference. The left drive wheel **102** has an inner rim **106**. The right drive wheel **108** has an inner rim **112**. In each case, the inner rim is smaller in diameter than the outer rim. In each case, a shoulder extends between the outer rim and the inner rim. The left drive wheel **102** has a shoulder **105**. The right drive wheel **108** has a shoulder **111**.

Each drive wheel outer rim **104** and **110** has a plurality of teeth **96** projecting radially outward from the rim surface. The teeth **96** are spaced uniformly apart around the outer rim circumference.

The left driven wheel **84** is aligned with the left drive wheel **102** in the process direction. The right driven wheel **90** is aligned with the right drive wheel **108** in the process direction. At least one drive motor **114** operatively drives at least one of the drive wheels. Typically, two drive motors **114** with drive belts are utilized, each motor operatively driving one of the drive wheels **102**, **108**.

A plurality of links **120** is provided. At least one of the plurality of links **120** is a spar link **160** and holds the media sheet LE **56** down, as will be explained below. The remaining links are vacuum links **140**, which also hold the media sheet down, using vacuum. Typically, multiple spar links **160** are employed. The spar links **160** are spaced apart according to the sheet to sheet pitch. The sheet pitch is fixed for a particular printer, and would need to accommodate the largest sheet process length. The links in between adjacent spar links **160** are vacuum links **140**. The links are preferably made of aluminum.

An endless belt **134** is formed by the plurality of links **120** operatively connected together. The endless belt **134** extends partway around the drive wheels **102**, **108**, and partway around the driven wheels **84**, **90**. The endless belt **134** also extends between the drive wheels and the driven wheels. The endless belt **134** is operatively drivingly attached to the drive wheels **102**, **108**. The endless belt **134** comprises the transport **70** that supports and conveys the media sheet **54** along the process path **44**. A pair of idler wheels **302**, one on each side of the frame, presses downward to tension the endless belt **134**. The idler wheels **302** are mounted on pivot arms **304** and biased by springs **306**.

Each link **120** extends between opposite ends transversely to the process direction. Each link **120** has a left end **122** disposed adjacent the left side frame **72** and an opposite right end **124** disposed adjacent the right side frame **74**. Each link **120** has a link surface **136** facing outward away from the endless belt **134**.

Each link **120** has two opposed generally parallel link edges **126** extending transversely to the side frames **72**, **74**. Each link edge **126** has serrations **128** interlaced with corresponding serrations **128** along the link edge **126** on each adjacent link **120**. In this manner, the link edges **126** will support the media sheet **54** transversely across the transport **70**. The serrations **128** prevent the media sheet **54** from being drawn downward in between links **120** due to the vacuum. In the embodiment shown, the serrations **128** do not form a hinge. However, the serrations **128** can be rolled to form a knuckle, and a hinge pin (not shown) inserted to form a piano hinge structure. The drawings, description, and claims herein disclose the best mode for carrying out the invention, and are non-limiting.

Each link **120** has a left drive hole **130** adjacent the left end **122** and a right drive hole **132** adjacent the right end **124**. The left drive hole **130** is adapted to receive and release one of the left drive wheel teeth **96**. The right drive hole **132** is adapted to receive and release one of the right drive wheel teeth **96**. In this manner, the drive wheel teeth **96** will operatively engage and drive the links **120**, causing the endless belt **134** to orbit the drive wheels **102**, **108**, and the driven wheels **84**, **90**.

The plurality of links **120** includes a plurality of vacuum links **140**. Each vacuum link **140** has a left tracking pin **98** adjacent the left end **122** and a right tracking pin **99** adjacent the right end **124**. The left tracking pin **98** is adapted to ride on the inner rim **106** and against the shoulder **105** of the left drive wheel **102**. The left tracking pin **98** also rides on the inner rim **88** and against the shoulder **87** of the left driven wheel **84**. The right tracking pin **99** is adapted to ride on the inner rim **112** and against the shoulder **111** of the right drive wheel **108**. The right tracking pin **99** also rides on the inner rim **94** and against the shoulder **93** of the right driven wheel **90**. The left tracking pin **98** and right tracking pin **99** serve to retain the endless belt **134** tracking generally centered on the transport **70**. The tracking pins **98**, **99**, prevent the endless belt **134** from running off the wheels to the left or right side.

A vacuum plenum **138** is disposed beneath the endless belt **134**. A vacuum source **139** communicates with the vacuum plenum **138** to supply vacuum. Typically, two vacuum plenums **138** are disposed beneath the endless belt **134**, as shown in FIG. **12**. The vacuum holds the media sheet **54** down against the transport **70**. The two vacuum plenums **138** also serve to support the endless belt **134** and keep it flat. No platen or supporting plate is needed, as with the prior art. The vacuum plenums **138** are preferably, but non-limitingly, made of acetal or HDPE.

The vacuum links **140** each include a vacuum link surface **142** facing outward away from the endless belt **134**. The vacuum links **140** each include a hollow chamber **144** attached to the link below the vacuum link surface **142**. The hollow chamber **144** attached to the vacuum link **140** together form a tube that can resist torsion, and thus hold flatness across the length and width of the vacuum link surface **142**. The hollow chamber **144** is disposed above the vacuum plenum **138**, as shown in FIG. **11**. The hollow chamber **144** has at least one aperture **146** through the chamber communicating with the vacuum plenum **138**. As shown in FIGS. **12**, **13**, and **16**, the hollow chamber **144** has two oval apertures **146**. One oval aperture **146** is aligned with each of the two vacuum plenums **138** beneath the endless belt **134**. The vacuum plenums **138** are open along the top, to communicate the vacuum to the oval apertures **146**. The vacuum link surface **142** has a plurality of holes **148** through the surface communicating with the hollow chamber **144**. The holes **148** are approximately 1.5 mm dia.×25 mm pitch. Thus, the vacuum is applied to the media sheet **54** for holding the media sheet **54** generally flat against the vacuum link surface **142** as the links **120** move over the vacuum plenum **138** in the process direction **44**. Preferably, at least −0.1 inch water pressure vacuum is applied to hold the media sheet **54** down. The vacuum link surface **142** has a smoothness of about 32 μinch finish to help spread the vacuum across the area beneath the media sheet **54**.

At least one spar **150** is coextensive with the one of the plurality of links **120** defining the spar link **160**. Typically, multiple spar links **160** are provided, each spar link **160** having one spar **150**. The opposite ends of the spar **150** are juxtaposed with the spar link **160** respective opposite ends. The spar **150** extends between a spar left end **152** disposed adjacent the spar link left end **122** and an opposite spar right end **154** disposed adjacent the spar link right end **124**. The spar link **160** has a spar link surface **162** facing outward away from the endless belt **134**. The spar link **160** has a slot **164** extending through the spar link surface **162** to receive the spar **150**. The spar **150** is adapted to move into a retracted position below the spar link surface **162**. The spar **150** is also adapted to move into an extended position above the spar link surface **162**.

The spar **150** is L-shaped in cross-section uniformly between the spar ends **152**, **154**. The spar **150** has a mount flange **156** and a clamp flange **158**, which together form the L-shape. The spar mount flange **156** extends between the spar left end **152** and the spar right end **154**. The spar clamp flange **158** extends between the spar left end **152** and the spar right end **154**. The spar clamp flange **158** is disposed at generally a right angle to the spar mount flange **156**.

The spar **150** is adapted to move into a clamping position with the media sheet lead edge **56** sandwiched between the clamp flange **158** and the spar link surface **162**. In this position, the spar **150** will hold the media sheet lead edge **56** clamped against the spar link surface **162**. The media sheet **54** will thus pass beneath the inkjet print head **43** without contacting the inkjet print head **43**. Bleed holes **166** allow trapped air to escape.

At least one flexible drive belt **170** is attached to each link **120** of the plurality of links to pivotally connect each link **120** together. Typically two flexible drive belts **172**, **174**, are employed. A left flexible drive belt **172** is attached to each link **120** adjacent the left end **122**. A right flexible drive belt **174** is attached to each link **120** adjacent the right end **124**. Each flexible drive belt **172**, **174** has a plurality of drive holes **176** that align with the link drive holes **130**, **132**. In this manner, the drive wheel teeth **96** will operatively engage and drive the drive belts **172**, **174**, as well as the links **120**. The left **172** and right **174** flexible drive belts pivotally connect each link **120** together and operatively move each link **120** in the process direction. The drive belts **172**, **174** are each preferably comprised of a Kevlar® timing belt or a stainless steel flat belt. The material is non-limiting, as any flexible material having low stretch and a high fatigue life can be employed.

At least one lift cam **178** is provided, and typically two lift cams are utilized. A left lift cam **180** has an entry portion **182** with an entry profile **184**, and an exit portion **186** with an exit profile **188**. The entry profile **184** defines the shape of the entry portion **182**. The exit profile **188** defines the shape of the exit portion **186**. The left lift cam **180** lies generally in a plane generally parallel to the left side frame **72**. The left lift cam **180** lies inboard of the left side frame **72** and the left driven **84** and drive **102** wheels. The left lift cam entry portion **182** is juxtaposed with the left driven wheel **84**. The left lift cam exit portion **186** is juxtaposed with the left drive wheel **102**.

A left lift track **190** extends between the left lift cam entry portion **182** and the left lift cam exit portion **186**. The left lift track **190** is straight and joins the left lift cam entry and exit portions.

A right lift cam **200** has an entry portion **202** with an entry profile **204**, and an exit portion **206** with an exit profile **208**. The entry profile **204** defines the shape of the entry portion **202**. The exit profile **208** defines the shape of the exit portion **206**. The right lift cam **200** lies generally in a plane generally parallel to left lift cam **180**. The right lift cam **200** lies inboard of the right side frame **74** and the right driven **90** and drive **108** wheels. The right lift cam entry portion **202** is juxtaposed with the right driven wheel **90**. The right lift cam exit portion **206** is juxtaposed with the right drive wheel **108**. The right lift cam **200** is similar and opposite-hand to the left lift cam **180**.

A right lift track **210** extends between the right lift cam entry portion **202** and the right lift cam exit portion **206**. The right lift track **210** is straight and joins the right lift cam entry and exit portions.

At least one tilt cam **218** is provided, and typically two tilt cams are utilized. A left tilt cam **220** has an entry portion **222** with an entry profile **224**, and an exit portion **226** with an exit profile **228**. The entry profile **224** defines the shape of the entry portion **222**. The exit profile **228** defines the shape of the exit portion **226**. The left tilt cam **220** lies generally in a plane generally parallel to the left lift cam **180**. The left tilt cam entry portion **222** is juxtaposed with the left lift cam entry portion **182**. The left tilt cam exit portion **226** is juxtaposed with the left lift cam exit portion **186**. The left tilt cam **220** is disposed against the left lift cam **180** and inboard of the left lift cam **180**, as shown in FIG. **12**.

The function of the combined lift and tilt motion at the entry portions **202**, **222** is to raise the spar **150** to a maximum height to catch the sheet **54** from the registration system. The sheet **54** will stop against the spar **150** with a slight buckle registration in the process direction **44** to ensure the correct and full clamp of the lead edge **56** of the sheet **54**.

The function of the combined lift and tilt cams at the exit portions **186**, **226**, is opposite to that of the entry. The spar **150** first lifts away from the lead edge **56**. The spar **150** then rotates and tucks or retracts down into the slot **164** to eliminate a catch point as the sheet **54** exits the transport **70**

A left tilt track **230** extends between the left tilt cam entry portion **222** and the left tilt cam exit portion **226**. The left tilt track **230** is straight and joins the left tilt cam entry and exit portions.

A right tilt cam **240** has an entry portion **242** with an entry profile **244**, and an exit portion **246** with an exit profile **248**. The entry profile **244** defines the shape of the entry portion **242**. The exit profile **248** defines the shape of the exit portion **246**. The right tilt cam **240** lies generally in a plane generally parallel to the right lift cam **200**. The right tilt cam entry portion **242** is juxtaposed with the right lift cam entry portion **202**. The right tilt cam exit portion **246** is juxtaposed with the right lift cam exit portion **206**. The right tilt cam **240** is disposed against the right lift cam **200** and inboard of the right lift cam **200**, as shown in FIG. **12**. The right tilt cam **240** is similar and opposite-hand to the left tilt cam **220**.

A right tilt track **250** extends between the right tilt cam entry portion **242** and the right tilt cam exit portion **246**. The right tilt track **250** is straight and joins the right tilt cam entry and exit portions.

At least one lift follower is attached to the at least one spar link **160**. Typically, multiple spar links **160** are provided, as described above. Each spar link **160** has two lift followers. A left lift follower **260** is pivotally attached to the spar link left end **122**. The spar left end **152** is operatively connected to the left lift follower **260**. In this embodiment, the spar left end **152** is not directly mounted on the left lift follower **260**, but can be as an option. The spar mounting disclosed is non-limiting. The left lift follower **260** has two components, a lever and a roller. A left lift lever **262** proximal end **264** is pivotally mounted on the spar link left end **122**. The left lift lever **262** distal end **266** has a left lift roller **268** mounted for rotation. The left lift roller **268** is in contact with the left lift cam entry portion **182**, and the left lift track **190**, and the left lift cam exit portion **186**.

A right lift follower **270** is pivotally attached to the spar link right end **124**. The spar right end **154** is operatively connected to the right lift follower **270**. In this embodiment, the spar right end **154** is not directly mounted on the right lift follower **270**, but can be as an option. The spar mounting disclosed is non-limiting. The right lift follower **270** has two components, a lever and a roller. A right lift lever **272** proximal end **274** is pivotally mounted on the spar link right end **124**. The right lift lever **272** distal end **276** has a right lift roller **278** mounted for rotation. The right lift roller **278** is in contact with the right lift cam entry portion **202**, and the right lift track **210**, and the right lift cam exit portion **206**.

The right **270** and left **260** lift followers are adapted to follow the right **204** and left **224** lift cam entry profiles respectively. The lift followers **260**, **270** move the spar **150** from the retracted position shown in FIGS. **18** and **21**, to the extended position shown in FIGS. **19**, **20**, and **22**, wherein the spar **150** is ready to receive the media sheet **54** lead edge **56**. The lift followers **260**, **270** then move the spar **150** to the clamping position shown in FIGS. **23** and **24**, to clamp the media sheet **54** down against the spar link **160**. An optional nip roller **300** with a foam roll covering will flatten the media sheet **54** prior to clamping and prior to passing over the vacuum plenum **138**. This roller ensures good flatness to the vacuum slats.

The right **270** and left **260** lift followers are adapted to then follow the right **210** and left **190** lift tracks respectively. The lift tracks are straight, and thus will allow the lift followers **260**, **270** to retain the spar **150** in the clamping position during printing. This holds the media sheet **54** down in order to pass beneath the inkjet print head **43** without contacting the inkjet print head **43**.

The right **270** and left **260** lift followers are adapted to next follow the right **208** and left **188** lift cam exit profiles respectively. The lift followers **260**, **270** move the spar **150** from the clamping position shown in FIG. **25** to the extended position shown in FIG. **26** to unclamp the media sheet **54**. The lift followers **260**, **270** then move the spar **150** from the extended position to the retracted position shown in FIG. **28**, allowing the media sheet **54** to exit the transport **70**. This tuck, or retracted, position occurs so that the spar **150** will move ahead of the lead edge **56** of the sheet **54** that is exiting. This retracted position will prevent the spar **150** from catching and jamming the sheet **54** as it exits the transport **70**.

At least one tilt follower is operatively connected to the at least one spar link **160**. Typically, multiple spar links **160** are provided, as described above. Each spar link **160** has two tilt followers. Each spar **150** is typically mounted on the tilt followers.

A left tilt follower **280** is pivotally attached to the left lift follower **260**. The left tilt follower **280** has two components, a lever and a roller. A left tilt lever **282** proximal end **284** is pivotally mounted on the left lift follower **260**. The left tilt lever **282** distal end **286** has a left tilt roller **288** mounted for rotation. The left tilt roller **288** is in contact with the left tilt cam entry portion **222**, and the left tilt track **230**, and the left tilt cam exit portion **226**. The spar mount flange **156** at the spar left end **152** is mounted on the left tilt follower **280**. The spar mounting disclosed is non-limiting.

A right tilt follower **290** is pivotally attached to the right lift follower **270**. The right tilt follower **290** has two components, a lever and a roller. A right tilt lever **292** proximal end **294** is pivotally mounted on the right lift follower **270**. The right tilt lever **292** distal end **296** has a right tilt roller **298** mounted for rotation. The right tilt roller **298** is in contact with the right tilt cam entry portion **242**, and the right tilt track **250**, and the right tilt cam exit portion **246**. The spar mount flange **156** at the spar right end **154** is mounted on the right tilt follower **290**. The spar mounting disclosed is non-limiting.

The right **290** and left **280** tilt followers are adapted to follow the right **244** and left **224** tilt cam entry profiles respectively. Thus, the tilt followers **290**, **280**, move the spar **150** from the tilted position into the upright position shown in FIG. **22**, prior to the clamping position shown in FIGS. **23-24**. The tilted position allows the spar **150** to pass through the slot **164** in the spar link surface **162**. After passing through the slot **164**, the tilt followers **290**, **280**, move the spar **150** into the upright position.

The right **290** and left **280** tilt followers are adapted to follow the right **250** and left **230** tilt tracks respectively. Since the tilt tracks **230**, **250**, are straight, the spar **150** does not tilt in this region. This is proper, since the spar **150** is in the clamping position.

The right **290** and left **280** tilt followers are adapted to follow the right **248** and left **228** tilt cam exit profiles respectively. The spar **150** thereby moves from the upright position shown in FIG. **26**, into the tilted position shown in FIG. **27**, prior to the retracted position shown in FIG. **28**. Note that the spar **150** moves ahead of the lead edge **56** of the sheet **54** to prevent buckling of the sheet **54** on the endless belt **134**. The tilted position allows the spar **150** to pass through the slot **164** in the spar link surface **162** so that the spar **150** can be retracted. The timing of the followers **260**, **270**, **280** and **290** around the cam orbital path determines elevation and tilt angle of the spar **150** for both entrance and exit portions.

A torsion spring (not shown) operatively connected to either the lift or tilt followers holds the spar **150** in the retracted position. The torsion spring provides the clamping force or bias exerted by the spar **150** on the sheet **54** during transport. The lift and tilt cams act upon the lift and tilt followers to overcome the spring bias.

A plurality of slides **308** is provided for sliding the transport **70** outward from the printer **40**. The slides **308** are linear bearings that allow the transport **70** to move laterally out from under the marking engine **42** so as not to damage the print heads **43** during maintenance. This also allows easy access to the entire transport **70**.

A method is disclosed for holding a media sheet **54** down on the transport **70**. The method comprises connecting a plurality of links **120** pivotally together and orbiting the links **120** edgewise around drive wheels **102**, **108**, and driven wheels **84**, **90**. This will form an endless belt **134** defining the transport **70**. The media sheet **54** is transported in the process direction **44** with the endless belt **134**.

A spar **150** is movably mounted on at least one link **120** of the plurality of links. The spar **150** is moved into a clamping position with a cam **178**, **218**, and follower **260**, **270**, **280**, **290**. The media sheet lead edge **56** is clamped to the at least one link **120** by means of the spar **150**. The media sheet **54** is held generally flat against the endless belt **134** surface with the spar **150** during printing. The spar **150** moves into an extended position with the cam and follower so as to release the media sheet. The spar **150** moves into a retracted position with the cam and follower so as to allow the media sheet **54** to exit the transport **70**.

Adjacent links **120** are disposed together along two opposed generally parallel link edges **126** of each link **120**. Each link **120** is extended between opposite ends **122**, **124**, transversely to the process direction **44**. The at least one link **120** having the spar **150** is a spar link **160**. The remaining links are vacuum links **140**.

The spar **150** is formed into an L-shaped cross-section uniformly between opposite spar ends **152**, **154**. The cross-section has a spar mount flange **156** and a spar clamp flange **158**. A spar link surface **162** faces outward from the spar link **160** and away from the endless belt **134**. A slot **164** is extended through the spar link surface **162**. The spar **150** is received in the slot **164**.

The media sheet lead edge **56** is sandwiched between the clamp flange **158** and the spar link surface **162**. The media sheet lead edge **56** is held clamped against the spar link surface **162** during printing. This allows the media sheet **54** to pass beneath the inkjet print head **43** without contacting the inkjet print head **43**.

At least one flexible drive belt **170** is extended around the drive wheels **102**, **108**, and the driven wheels **84**, **90**. Each link **120** of the plurality of links is attached to the flexible drive belt **170**, which pivotally connects each link together.

Each link **120** moves operatively in an orbital manner around the drive wheels **102**, **108**, and the driven wheels **84**, **90** with the flexible drive belt **170**. Serrations **128** are formed along each link edge **126**. The serrations **128** are interlaced with corresponding serrations **128** on each adjacent link **120**. The serrations **128** support the media sheet **54** transversely across the transport **70**.

A vacuum plenum **138** is disposed beneath the endless belt **134**. A vacuum source **139** communicates with the vacuum plenum **138** to supply vacuum. A vacuum link surface **142** faces outward from the vacuum link **140** and away from the endless belt **134**. A hollow chamber **144** is attached to each vacuum link **140** below the link surface **142**. The hollow chamber **144** is disposed above the vacuum plenum **138**.

At least one aperture **146** is formed through the hollow chamber **144**. The aperture **146** communicates with the vacuum plenum **138**. A plurality of holes **148** is formed through the vacuum link surface **142**. The holes **148** communicate with the hollow chamber **144**. Vacuum is applied to the media sheet **54** through the plurality of holes **148**. The vacuum serves to hold the media sheet **54** generally flat against the vacuum link surface **142** as the links **120** move over the vacuum plenum **138** in the process direction **44**.

The media sheet **54** can be buckle registered by means of the spar **150**. The registration would be achieved prior to clamping the media sheet lead edge **56** to the link **120** with the spar **150**. A slot sensor (not shown) will be used to time the spar location and edge of sheet to create a start of print signal to register the image with respect to the lead edge of the sheet.

It will be appreciated that variants of the above-disclosed and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What is claimed is:

1. A transport with media hold down for use in connection with an inkjet printer having an inkjet print head, and a media sheet having a lead edge and a trail edge, the media sheet moving in a process direction along a process path, the transport with media hold down comprising:

a frame extending longitudinally in the process direction from a first end to an opposite second end;

at least one first axle mounted on the frame at the first end;

a pair of driven wheels mounted for rotation on the at least one first axle;

at least one second axle mounted on the frame at the second end;

a pair of drive wheels mounted for rotation on the at least one second axle;

at least one drive motor operatively driving at least one of the drive wheels;

a plurality of links operatively connected together, each link extending between opposite ends transversely to the process direction, each link having two opposed generally parallel link edges, each link edge being juxtaposed with an adjacent link edge on each adjacent link, the plurality of links being operatively drivingly attached to the drive wheels, each link being adapted for pivotal motion with respect to each adjacent link, each link having a link surface facing outward, the plurality of links being adapted for holding the media sheet generally flat against each link surface and conveying the media sheet in the process direction, at least one of the plurality of links being a spar link, and the remaining links being vacuum links;

at least one spar extending between opposite ends juxtaposed with the spar link opposite ends, the spar link having a spar link surface facing outward, the spar link having a slot extending through the spar link surface to receive the spar, the spar being adapted to move into a retracted position below the spar link surface, the spar being adapted to move into an extended position above the spar link surface, the spar having a clamp flange, the spar being adapted to move into a clamping position with the media sheet lead edge sandwiched between the clamp flange and the spar link surface, so as to hold the media sheet lead edge clamped against the spar link surface, wherein the media sheet will pass beneath the inkjet print head without contacting the inkjet print head;

at least one lift cam having an entry portion with an entry profile disposed adjacent the first end, the lift cam having an exit portion with an exit profile disposed adjacent the second end; and

at least one lift follower attached to the at least one spar link, the spar being operatively connected to the lift follower; wherein

the lift follower is adapted to follow the lift cam entry profile so as to move the spar from the retracted position to the extended position to receive the media sheet and to the clamping position to clamp the media sheet; and

the lift follower is adapted to follow the lift cam exit profile so as to move the spar from the clamping position to the extended position to release the media sheet from the clamping position and to the retracted position, allowing the media sheet to exit the transport.

2. The transport with media hold down of claim **1**, further comprising an endless belt formed by the plurality of links operatively connected together, the endless belt extending partway around the drive wheels and partway around the driven wheels, the endless belt extending between the drive wheels and the driven wheels, the endless belt being operatively drivingly attached to the drive wheels so as to be driven in an orbital motion around the drive wheels and the driven wheels.

3. The transport with media hold down of claim 2, further comprising:

a vacuum plenum disposed beneath the endless belt;

a vacuum source communicating with the vacuum plenum to supply vacuum;

wherein the vacuum links each further comprise:

a hollow chamber attached to the vacuum link below the link surface, the hollow chamber being disposed above the vacuum plenum, the hollow chamber having apertures therethrough communicating with the vacuum plenum; and

a vacuum link surface facing outward away from the endless belt, the vacuum link surface having a plurality of holes therethrough communicating with the hollow chamber so as to apply vacuum to the media sheet for holding the media sheet generally flat against the vacuum link surface as the links move over the vacuum plenum in the process direction.

4. The transport with media hold down of claim 3, further comprising:

the pair of drive wheels further comprises a left drive wheel and a right drive wheel, the left and right drive wheels being mounted for rotation on the at least one second axle, the left and right drive wheels each having an outer rim with a circumference, an inner rim with a circumference, the inner rim being smaller in diameter than the outer rim, and a shoulder extending between the outer rim and the inner rim;

the pair of driven wheels further comprises a left driven wheel and a right driven wheel, the left and right driven wheels being mounted for rotation on the at least one first axle, the left and right driven wheels each having an outer rim with a circumference, an inner rim with a circumference, the inner rim being smaller in diameter than the outer rim, and a shoulder extending between the outer rim and the inner rim; and

the vacuum links further comprise each vacuum link extending between a left end and an opposite right end, each vacuum link having a left tracking pin adjacent the left end, the left tracking pin being adapted to ride on the inner rim and against the shoulder of the left drive wheel and the left driven wheel, each vacuum link having a right tracking pin adjacent the right end, the right tracking pin being adapted to ride on the inner rim and against the shoulder of the right drive wheel and the right driven wheel, so as to retain the endless belt tracking generally centered on the transport.

5. The transport with media hold down of claim 2, wherein:

the pair of drive wheels further comprises a left drive wheel and a right drive wheel, the left and right drive wheels being mounted for rotation on the at least one second axle, the left and right drive wheels each having an outer rim with a circumference, each outer rim having a plurality of teeth projecting radially outward therefrom, the teeth being spaced uniformly apart around the circumference; and

the plurality of links further comprises each link extending between a left end and an opposite right end, each link having a left drive hole adjacent the left end, the left drive hole being adapted to receive and release a one of the left drive wheel teeth, each link having a right drive hole adjacent the right end, the right drive hole being adapted to receive and release a one of the right drive wheel teeth, so as to operatively drivingly attach the endless belt to the drive wheels.

6. The transport with media hold down of claim 1, further comprising at least one flexible drive belt attached to each link of the plurality of links to pivotally connect each link together and adapted to operatively move the plurality of links in an orbital motion around the drive wheels and the driven wheels.

7. The transport with media hold down of claim 1, further comprising:

at least one tilt cam having an entry portion with an entry profile juxtaposed with the lift cam entry portion, the tilt cam having an exit portion with an exit profile juxtaposed with the lift cam exit portion; and

at least one tilt follower operatively connected to the at least one spar link, the spar being mounted on the tilt follower; wherein

the spar is adapted to move into a tilted position, so as to pass through the spar link slot and into an upright position prior to the clamping position;

the tilt follower is adapted to follow the tilt cam entry profile so as to move the spar from the tilted position into the upright position; and

the tilt follower is adapted to follow the tilt cam exit profile so as to move the spar from the upright position into the tilted position prior to the retracted position.

8. The transport with media hold down of claim 7, further comprising:

a lift track extending between the lift cam entry portion and the lift cam exit portion; and

a tilt track extending between the tilt cam entry portion and the tilt cam exit portion; wherein

the lift follower is adapted to follow the lift track so as to retain the spar in the clamping position; and

the tilt follower is adapted to follow the tilt track so as to retain the spar in the upright position.

9. The transport with media hold down of claim 8, wherein:

the spar further comprises a mount flange and a clamp flange forming an L-shaped cross-section extending uniformly between the spar ends;

the at least one lift follower is pivotally attached to the at least one spar link;

the at least one tilt follower is pivotally attached to the lift follower; and

the spar mount flange is mounted on the tilt follower.

10. The transport with media hold down of claim 1, further comprising:

each link extending between a left end and an opposite right end;

a right flexible drive belt attached to each link adjacent the right end; and

a left flexible drive belt attached to each link adjacent the left end; wherein

the left and right flexible drive belts pivotally connect each link together and are adapted to operatively move the plurality of links in an orbital motion around the drive wheels and the driven wheels.

11. A transport with media hold down for use in connection with an inkjet printer having an inkjet print head, and a media sheet having a lead edge and a trail edge, the media sheet moving in a process direction along a process path, the transport with media hold down comprising:

a pair of side frames generally parallel and spaced apart, the side frames extending longitudinally in the process direction between opposite first and second ends, the second ends being downstream in the process direction from the first ends;

at least one cross frame extending transversely between the side frames;

at least one first axle mounted on the side frames at the first ends;

a pair of driven wheels mounted for rotation on the at least one first axle;

at least one second axle mounted on the side frames at the second ends;

a pair of drive wheels mounted for rotation on the at least one second axle;

at least one drive motor operatively driving at least one of the drive wheels;

a plurality of links, each link extending between opposite ends transversely to the process direction, the opposite ends being disposed adjacent the side frames, each link having two opposed generally parallel link edges extending transverse to the side frames, each link edge having serrations interlaced with corresponding serrations along the link edge on each adjacent link, so as to support the media sheet transversely across the transport;

at least one flexible drive belt attached to each link of the plurality of links to pivotally connect each link together, the flexible drive belt being adapted to operatively move the plurality of links in an orbital motion around the drive wheels and the driven wheels;

an endless belt formed by the plurality of links operatively connected together, the endless belt extending partway around the drive wheels and partway around the driven wheels, the endless belt extending between the drive wheels and the driven wheels, the endless belt being operatively drivingly attached to the drive wheels, each link having a link surface facing outward away from the endless belt, the plurality of links being adapted for holding the media sheet generally flat against each link surface and conveying the media sheet in the process direction, at least one of the plurality of links being a spar link, and the remaining links being vacuum links;

at least one spar extending between opposite ends juxtaposed with the spar link opposite ends, the spar being coextensive with the one of the plurality of links defining the spar link, the spar link having a spar link surface facing outward away from the endless belt, the spar link having a slot extending through the spar link surface to receive the spar, the spar being adapted to move into a retracted position below the spar link surface, the spar being adapted to move into an extended position above the spar link surface, the spar being L-shaped in cross-section uniformly between the spar ends, the spar having a mount flange and a clamp flange forming the L-shape, the spar being adapted to move into a clamping position with the media sheet lead edge sandwiched between the clamp flange and the spar link surface, so as to hold the media sheet lead edge clamped against the spar link surface, wherein the media sheet will pass beneath the inkjet print head without contacting the inkjet print head;

at least one lift cam having an entry portion with an entry profile, and an exit portion with an exit profile, and a lift track extending between the entry portion and the exit portion, the lift cam lying generally in a plane generally parallel to the side frames, the entry portion being juxtaposed with a one of the driven wheels and the exit portion being juxtaposed with a corresponding one of the drive wheels; and

at least one lift follower attached to the at least one spar link, the spar being operatively connected to the lift follower; wherein

the lift follower is adapted to follow the lift cam entry profile so as to move the spar from the retracted position to the extended position to receive the media sheet and to the clamping position to clamp the media sheet;

the lift follower is adapted to follow the lift track so as to retain the spar in the clamping position; and

the lift follower is adapted to follow the lift cam exit profile so as to move the spar from the clamping position to the extended position to release the media sheet from the clamping position and to the retracted position, allowing the media sheet to exit the transport.

12. The transport with media hold down of claim **11**, further comprising:

at least one tilt cam having an entry portion with an entry profile, and an exit portion with an exit profile, and a tilt track extending between the entry portion and the exit portion, the tilt cam lying generally in a plane generally parallel to the lift cam, the tilt cam entry portion being juxtaposed with the lift cam entry portion and the tilt cam exit portion being juxtaposed with the lift cam exit portion; and

at least one tilt follower operatively connected to the at least one spar link, the spar being mounted on the tilt follower; wherein

the spar is adapted to move into a tilted position, so as to pass through the spar link slot and into an upright position prior to the clamping position;

the tilt follower is adapted to follow the tilt cam entry profile so as to move the spar from the tilted position into the upright position;

the tilt follower is adapted to follow the tilt track; and

the tilt follower is adapted to follow the tilt cam exit profile so as to move the spar from the upright position into the tilted position prior to the retracted position.

13. The transport with media hold down of claim **12**, wherein:

the at least one lift follower is pivotally attached to the at least one spar link;

the at least one tilt follower is pivotally attached to the lift follower; and

the spar mount flange is mounted on the tilt follower.

14. The transport with media hold down of claim **11**, further comprising:

a vacuum plenum disposed beneath the endless belt;

a vacuum source communicating with the vacuum plenum to supply vacuum;

wherein the vacuum links each further comprise:

a hollow chamber attached to the link below the link surface, the hollow chamber being disposed above the vacuum plenum, the hollow chamber having apertures therethrough communicating with the vacuum plenum; and

a vacuum link surface facing outward away from the endless belt, the vacuum link surface having a plurality of holes therethrough communicating with the hollow chamber so as to apply vacuum to the media sheet for holding the media sheet generally flat against the vacuum link surface as the links move over the vacuum plenum in the process direction.

15. The transport with media hold down of claim **11**, wherein:

the pair of drive wheels further comprises a left drive wheel and a right drive wheel, the left and right drive wheels being mounted for rotation on the at least one second axle, the left and right drive wheels each having an outer rim with a circumference, each outer rim having a plurality of teeth projecting radially outward therefrom, the teeth being spaced uniformly apart around the circumference; and

the plurality of links further comprises each link extending between a left end disposed adjacent the left side frame and an opposite right end disposed adjacent the right side frame, each link having a left drive hole adjacent the left end and a right drive hole adjacent the right end, the left drive hole being adapted to receive and release a one of the left drive wheel teeth, the right drive hole being adapted to receive and release a one of the right drive wheel teeth, so as to operatively drivingly attach the endless belt to the drive wheels.

16. The transport with media hold down of claim **14**, further comprising:

the pair of drive wheels further comprises a left drive wheel and a right drive wheel, the left and right drive wheels being mounted for rotation on the at least one second axle, the left and right drive wheels each having an outer rim with a circumference, an inner rim with a circumference, the inner rim being smaller in diameter than the outer rim, and a shoulder extending between the outer rim and the inner rim;

the pair of driven wheels further comprises a left driven wheel and a right driven wheel, the left and right driven wheels being mounted for rotation on the at least one first axle, the left and right driven wheels each having an outer rim with a circumference, an inner rim with a circumference, the inner rim being smaller in diameter than the outer rim, and a shoulder extending between the outer rim and the inner rim; and

the vacuum links further comprise each vacuum link extending between a left end disposed adjacent the left side frame and an opposite right end disposed adjacent the right side frame, each vacuum link having a left tracking pin adjacent the left end and a right tracking pin adjacent the right end, the left tracking pin being adapted to ride on the inner rim and against the shoulder of the left drive wheel and the left driven wheel, the right tracking pin being adapted to ride on the inner rim and against the shoulder of the right drive wheel and the right driven wheel, so as to retain the endless belt tracking generally centered on the transport.

17. The transport with media hold down of claim **11**, further comprising:

a right flexible drive belt attached to each link adjacent the link right end; and

a left flexible drive belt attached to each link adjacent the link left end, the left and right flexible drive belts pivotally connecting each link together and being adapted to operatively move the plurality of links in an orbital motion around the drive wheels and the driven wheels.

18. The transport with media hold down of claim **11**, wherein:

the pair of driven wheels further comprises a left driven wheel and a right driven wheel, the wheels being mounted for rotation on the at least one first axle;

the pair of drive wheels further comprises a left drive wheel and a right drive wheel, the wheels being mounted for rotation on the at least one second axle;

wherein the left driven wheel is aligned with the left drive wheel in the process direction, and the right driven wheel is aligned with the right drive wheel in the process direction;

the pair of side frames further comprises a left side frame and a right side frame;

the at least one lift cam further comprises:

a left lift cam having an entry portion with an entry profile, and an exit portion with an exit profile, and a left lift track extending between the entry portion and the exit portion, the left lift cam lying generally in a plane generally parallel to the left side frame, the left lift cam entry portion being juxtaposed with the left driven wheel and the left lift cam exit portion being juxtaposed with the left drive wheel;

a right lift cam having an entry portion with an entry profile, and an exit portion with an exit profile, and a right lift track extending between the entry portion and the exit portion, the right lift cam lying generally in a plane generally parallel to left lift cam, the right lift cam entry portion being juxtaposed with the right driven wheel and the right lift cam exit portion being juxtaposed with the right drive wheel;

the plurality of links further comprises each link extending between a left end disposed adjacent the left side frame and an opposite right end disposed adjacent the right side frame;

the at least one spar further comprises the spar extending between a spar left end disposed adjacent the spar link left end and an opposite spar right end disposed adjacent the spar link right end, the spar mount flange extending between the spar left end and the spar right end, the spar clamp flange extending between the spar left end and the spar right end, the spar clamp flange being disposed at generally a right angle to the spar mount flange;

the at least one lift follower further comprises:

a left lift follower pivotally attached to the spar link left end, the spar left end being operatively connected to the left lift follower; and

a right lift follower pivotally attached to the spar link right end, the spar right end being operatively connected to the right lift follower; wherein

the right and left lift followers are adapted to follow the right and left lift cam entry profiles respectively, so as to move the spar from the retracted position to the extended position and to the clamping position to clamp the media sheet;

the right and left lift followers are adapted to follow the right and left lift tracks respectively, so as to retain the spar in the clamping position; and

the right and left lift followers are adapted to follow the right and left lift cam exit profiles respectively, so as to move the spar from the clamping position to the extended position to unclamp the media sheet and to move the spar from the extended position to the retracted position, allowing the media sheet to exit the transport.

19. The transport with media hold down of claim **18**, wherein:

the at least one tilt cam further comprises:

a left tilt cam having an entry portion with an entry profile, and an exit portion with an exit profile, and a left tilt track extending between the entry portion and the exit portion, the left tilt cam lying generally in a plane generally parallel to the left lift cam, the left tilt cam entry portion being juxtaposed with the left lift cam entry portion and the left tilt cam exit portion being juxtaposed with the left lift cam exit portion; and

a right tilt cam having an entry portion with an entry profile, and an exit portion with an exit profile, and a right tilt track extending between the entry portion and the exit portion, the right tilt cam lying generally in a plane generally parallel to the right lift cam, the right tilt cam entry portion being juxtaposed with the right lift cam entry portion and the right tilt cam exit portion being juxtaposed with the right lift cam exit portion;

the at least one tilt follower further comprises:

a left tilt follower pivotally attached to the left lift follower, the mount flange at the spar left end being mounted on the left tilt follower; and

a right tilt follower pivotally attached to the right lift follower, the mount flange at the spar right end being mounted on the right tilt follower; wherein

the right and left tilt followers are adapted to follow the right and left tilt cam entry profiles respectively, so as to move the spar from the tilted position into the upright position prior to the clamping position;

the right and left tilt followers are adapted to follow the right and left tilt tracks respectively; and

the right and left tilt followers are adapted to follow the right and left tilt cam exit profiles respectively, so as to move the spar from the upright position into the tilted position prior to the retracted position.

20. A method for holding a media sheet down on a transport, for use in connection with an inkjet printer having an inkjet print head, and a media sheet having a lead edge and a trail edge, the media sheet moving in a process direction along a process path, the method comprising:

connecting a plurality of links pivotally together and orbiting the links edgewise around drive wheels and driven wheels to form an endless belt defining the transport;

transporting the media sheet in the process direction with the endless belt;

mounting a spar movably on at least one link of the plurality of links;

moving the spar into a clamping position with a cam and follower;

clamping the media sheet lead edge to the at least one link with the spar;

holding the media sheet generally flat against the endless belt surface with the spar during printing;

moving the spar into an extended position with the cam and follower so as to release the media sheet;

moving the spar into a retracted position with the cam and follower so as to allow the media sheet to exit the transport;

disposing adjacent links together along two opposed generally parallel link edges of each link, and extending each link between opposite ends transversely to the process direction, wherein the at least one link having the spar is a spar link, and the remaining links are vacuum links;

forming the spar into an L-shaped cross-section uniformly between opposite spar ends, wherein the cross-section has a spar mount flange and a spar clamp flange;

facing a spar link surface outward from the spar link and away from the endless belt;

extending a slot through the spar link surface and receiving the spar in the slot;

sandwiching the media sheet lead edge between the clamp flange and the spar link surface;

holding the media sheet lead edge clamped against the spar link surface during printing; and

allowing the media sheet to pass beneath the inkjet print head without contacting the inkjet print head.

21. The method of claim **20**, further comprising:

extending at least one flexible drive belt around the drive wheels and the driven wheels;

attaching each link of the plurality of links to the flexible drive belt so as to pivotally connect each link together;

operatively moving the plurality of links orbitally around the drive wheels and the driven wheels with the flexible drive belt; and

forming serrations along each link edge and interlacing the serrations with corresponding serrations on each adjacent link, so as to support the media sheet transversely across the transport.

22. The method of claim **21**, further comprising:

disposing a vacuum plenum beneath the endless belt;

communicating a vacuum source with the vacuum plenum to supply vacuum;

facing a vacuum link surface outward from the vacuum link and away from the endless belt;

attaching a hollow chamber to each vacuum link below the link surface;

disposing the hollow chamber above the vacuum plenum;

forming at least one aperture through the hollow chamber and communicating the aperture with the vacuum plenum;

forming a plurality of holes through the vacuum link surface and communicating the holes with the hollow chamber; and

applying vacuum to the media sheet through the plurality of holes so as to hold the media sheet generally flat against the vacuum link surface as the links move over the vacuum plenum in the process direction.

23. The method of claim **22**, further comprising buckle registering the media sheet with the spar prior to clamping the media sheet lead edge to the link with the spar.

24. A transport with media hold down for use in connection with an inkjet printer having an inkjet print head, and a media sheet having a lead edge and a trail edge, the media sheet moving in a process direction along a process path, the transport with media hold down comprising:

a pair of driven wheels;

a pair of drive wheels spaced apart from the driven wheels;

a plurality of links connected pivotally together to form an endless belt adapted for orbiting around the drive wheels and the driven wheels, wherein:

at least one of the plurality of links is a spar link having a spar link surface facing away from the endless belt, the spar link having a spar link slot; and

the remaining links are vacuum links, each having a hollow chamber communicating with a vacuum source, so as to hold the media sheet against the endless belt;

a cam disposed adjacent the endless belt;

a follower adapted to operatively follow the cam; and

at least one spar movably mounted on the spar link and received in the spar link slot, the spar being operatively connected to the follower, the spar having a clamp flange;

wherein:

the spar is adapted to move into an extended position above the spar link surface by the cam and follower so as to receive the media sheet;

the spar is adapted to move into a clamping position by the cam and follower with the media sheet lead edge sandwiched between the clamp flange and the spar link surface, so as to hold the media sheet lead edge clamped against the spar link surface, wherein the media sheet will pass beneath the inkjet print head without contacting the inkjet print head;

the spar is adapted to move into the extended position by the cam and follower so as to release the media sheet; and

the spar is adapted to move into a retracted position below the spar link surface by the cam and follower so as to allow the media sheet to exit the transport.

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